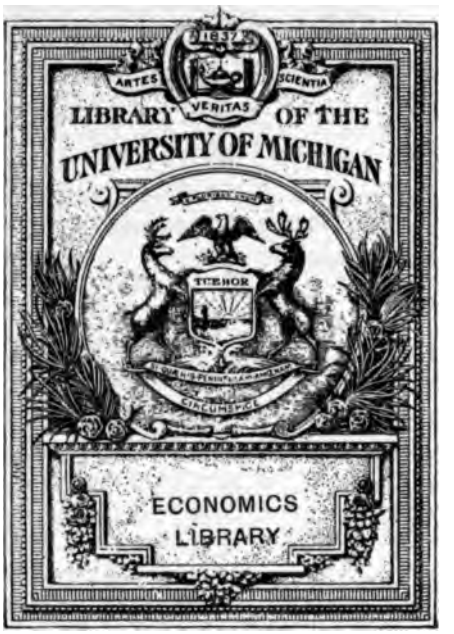
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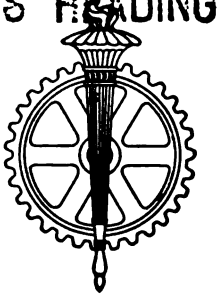
SCIENTIFIC MANAGEMENT
AND
RAILROADS

BEING PART OF A BRIEF SUBMITTED TO THE
INTERSTATE COMMERCE COMMISSION

BY
LOUIS D. BRANDEIS



NEW YORK
THE ENGINEERING MAGAZINE
1912

THE GREAT QUESTION INVOLVED

THE RAILROADS' POSITION

COMMISSIONER LANE. Is there any reason to believe that these increases would stop with the present increase if it should be allowed?

PRESIDENT WILLARD (of the Baltimore & Ohio). Increases in rates?

COMMISSIONER LANE. Increases in rates, yes, sir.

PRESIDENT WILLARD. No, I think not. I think the tendency of rates will be to continue upward.

COMMISSIONER LANE. You think there will have to be a progressive increase?

PRESIDENT WILLARD. Yes, sir.

(Record, p. 2188.)

THE SHIPPERS' POSITION

As an alternative to the railroads' practice of combining to increase rates we offer co-operation to reduce costs Instead of a dangerous makeshift, we offer a constructive policy — scientific management, under which as costs fall wages rise.

LET THE CONSUMER BEWARE

Of the vicious circle of ever increasing freight rates, and ever increasing cost of living.

PREFACE

The efficiency movement, of which scientific management is an important factor, expresses a new philosophy that conceives of conservation as the central motive in the conduct of industry. In an industrial system which, like ours today, is marked by the decline of competition as a force making for progress, the definite pursuit of efficiency is the only cure for a vicious cycle of increasing costs and increasing prices. Competition is not thereby discarded, but is directed to desirable ends and is balanced and controlled by finer constructive forces. It is changed from a strife to a stimulus.

The goal in view is the elimination of waste, because in the end waste can benefit nobody, and the apportionment of the savings among all concerned. The result is a softening of the struggle for existence, developing the faculties and increasing the happiness of the worker. Efficiency preaches a gospel of hope.

Efficiency is attained by the use of the best methods for the achievement of the best ideals. Ideals are spiritual, and know no limits except those which at any given time may be set by the circumstances surrounding a particular undertaking, or by the methods that our limited knowledge of science and the arts may impose. Efficiency in any particular case, therefore, is measured by the degree to which the opportunities of that case are realized.

About June, 1910, the railroads of the United States, operating East of the Mississippi and North of the Ohio and Potomac Rivers, acting in pursuance of a common purpose, filed with the Interstate Commerce Commission new tariffs providing for large advances in freight rates. The Commission ordered a public investigation as to the justice and reasonableness of the proposed increased rates, and

meanwhile suspended the operation of the new tariffs. The investigation occupied about six months.

In this investigation Mr. Louis D. Brandeis of Boston acted as counsel for the Traffic Committee of the Trade Organizations of the Atlantic Seaboard.

The railroads sought to justify the increased rates on the ground that they needed greater net income, and asserted that this need was due to increased operating costs, resulting mainly from higher wages. They contended that increased rates were imperative because the possibilities of economies in the operation of railroads had been practically exhausted.

Mr. Brandeis opposed the proposed advance on several grounds; but that which attracted most attention was his contention that there still existed in railroad operation huge possibilities of economies which could be attained by the introduction of scientific management—economies aggregating on all the American railroads "at least a million dollars a day."

On January 3, 1911, Mr. Brandeis submitted to the Commission a brief in which the evidence introduced at earlier hearings was referred to and discussed. About one-half of the brief related to the subject of scientific management. That part is now reprinted.

Railroad operation is a special case surrounded by many opportunities and beset by many difficulties. Where demand has been made imperative by competition (as in some passenger service), railroad efficiency is relatively high. When the measure of competition has not been in use (that is, in economy, or the equivalence between expenditure and return), railroad efficiency is relatively low. So long as the question of expenditure can be shifted to others for solution, it will not be answered by the railroads. Whenever some force as powerful as competition is brought to bear upon railway operating expenditures, costs as well as service will become efficient. The pursuit of efficiency through scientific management supplies this force.

Our easiest and surest instruction comes from the study of experience gained by others. The demonstration in the following pages is made wholly from practical experience.

The case which Mr. Brandeis builds up with masterly skill in construction and interpretation, is built of facts proved in industries differing from the railways only in outward form, but in no principle essential to the application of scientific management; for that management is applicable to any case in which men are employed to do work. The testimony affords abundant proof that the railways may find in scientific management the same happy results that manufacturers have invariably found—increased profits, decreased costs, ability to increase wages and to lower prices to their patrons—and this with easier, instead of harder, working conditions for the employees.

The proof is in Mr. Brandeis's pages, and needs no summary here. THE ENGINEERING MAGAZINE feels it a privilege to have been offered the opportunity to preserve and to present in book form this reproduction of that part of Mr. Brandeis's brief which covers the principles and results of scientific management. They are offered here, as they were offered by Mr. Brandeis, not in any spirit of controversy or criticism, but in a spirit of constructive effort and in dedication to a public service. C. B. G.

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THE RAILROADS' CONTENTION THAT THE POSSIBILITIES OF ECONOMIES IN OPERATION HAVE BEEN EXHAUSTED

The railroads contend that they have practically exhausted the possibilities of economies in operation.

(*a*) PRESIDENT MCCREA of the Pennsylvania Railroad said:

"So far as concerns economies which will result from reduction in grades, increasing hauling capacity of locomotives and increased capacity of cars, the Company is to-day already practically deriving the full benefits from those which are possible in this direction due to repairs heretofore made, for we have practically completed our grade levels, and have probably reached the maximum size of our cars and engines. . . . (P. 1957.)

Mr. BRANDEIS. . . . Now, Mr. McCrea, one other question. You stated that you thought the limit of increase in efficiency and resultant economy was practically reached.

Mr. MCCREA. I did, sir. (P. 2025.)

. . . . . .

Mr. BRANDEIS. . . . and that those methods of increasing efficiency — those more or less remunerative investments of property through increased efficiency — had, so far as you were aware, exhausted the improvements in the line of efficiency that you deemed possible?

Mr. MCCREA. In the line of economies. . . . You said 'efficiency'; I say 'economies.' That is about true. I said 'practically so'; that is my belief." (P. 2026.)

(*b*) PRESIDENT WILLARD, of the Baltimore and Ohio Railroad, said:

" Commissioner LANE. Do you think there should be an increase in rate every time there is a considerable increase in wages?

Mr. WILLARD. I think that depends. In my opinion the two things will be found to be very closely related to each other in the

future, and for the reason stated by Mr. McCrea yesterday, I think the possibilities of further operating economies have been pretty well exhausted. . . . I must confess that I am unable to see very much more that can be done in the way of reducing the cost of operation." (P. 2182.)

In substantially every other branch of manufacture, not controlled by trusts, including those much older than railroading and in which there has been the persistent prodding of competition, nearly every year still records important new economies. And (except where the tendency to reduce costs has been thwarted by an extraordinary rise in raw material or the control by a trust of some of the instruments of production) these economies in private manufacturing have been so great that they have generally been sufficient to prevent any rise in selling prices in spite of large increases in wages paid.

The contention that the possibilities of economy in railroading have been practically exhausted is contrary to all human experience in other lines of activity. Why then should the manufacture of railroad transportation be supposed to have reached the irreducible and now unmaintainable minimum of cost?

The railroads have introduced certain large economies within the last fifteen years; but these have been accomplished, mainly, through large expenditures of capital, as in leveling grades, straightening curves, strengthening bridges and road beds, making possible the use of larger cars and engines, and thus imposing also the great costs of the new equipment.

But advances in the art of transportation have been relatively few. Striking instances of failure to introduce advanced methods must be obvious to any careful observer. Most conspicuous perhaps is the persistence of the old methods of handling baggage and freight; for,

with few exceptions of very limited scope, the loading and unloading of ordinary freight are still conducted by hand substantially in the same manner as at the birth of railroading.

Indeed, the most marked advances made in connection with railroading in recent years have been forced upon the roads by law, against their strenuous opposition. This is true of the safety appliances, the abolition of rebates and passes, and, to a great extent, the abolition of grade crossings.

By some railroad managers the duty of finding new avenues to economy has been recognized, as shown by the following passages from the Report to Stockholders of the Lehigh Valley Road Company for the year ending June 30, 1910 (pp. 6, 19):

"It may be pointed out that the increases in revenue have occurred, with one exception, in each month of the year during a period when the general business of the country has not, to any appreciable extent, advanced, but on the other hand has during the last few months shown some evidence of receding. While the solicitation of both passenger and freight traffic has been actively carried on in competition with other lines, the increase may in large measure be ascribed to the high character of service rendered shippers and the traveling public, your management having consistently sought to improve the service, believing, as has undoubtedly been the case, that the revenues would respond to the improvement in the service.

Notwithstanding the high character of the service rendered and *with a liberal allowance* for *maintenance and depreciation of the property, the operating expenses* have increased but $1,108,410.93, or 5.39 per cent, over the preceding year, and are actually lower than for the fiscal years 1907 and 1908, when the earnings closely approximated those of the present year. It is particularly gratifying to observe that the expenses have been so controlled that the major portion of the increase in gross earnings has been retained in the net operating revenue, making the total of the latter $929,134.85 in excess of the best previous year. It is also pertinent to state that these results have been attained during a year when practically all

the elements of cost entering into the expense of operation have materially advanced. One of the most serious of these is the increase in rates of wages granted to all classes of employes. While this has affected the results for the year it has only been in the latter months, as the more important increases did not apply until after January 1st.

The ratio of operating expenses to operating revenues was 59.95 per cent, a decrease of 2.14 per cent, as compared with the preceding year. . . .

If for any reason, however, the gross revenues cannot be so increased, the constantly increasing cost of the service will diminish the net revenue of the Company and it becomes, therefore, of the utmost necessity to effect the greatest possible economies in operation. This problem of keeping the expenses of the Company within reasonable and well-defined limits, without any impairment of its physical well-being, has been given the most careful study and attention by your management, and many improved methods and economies have been introduced which have materially reduced the units of cost in various branches of the service."

ECONOMIES THROUGH SCIENTIFIC MANAGEMENT

It is undoubtedly true that even under the system of management prevailing among railroads, numerous economies are possible upon each railroad which, if introduced, would result in very large savings to that company, — savings far greater in amount than the added expense due to the recent increases in the wage scale. If, for instance, each railroad were now to adopt in each department the best methods and practices now prevailing in any other American railroad, it is clear that the operating expenses of each company would be very largely reduced.

But a far greater measure of economy would result to each company from the introduction of scientific management by which the efficiency of labor, plant and machinery, and materials would be very largely increased. Scientific management increases efficiency; and economy comes as a biproduct.

The science of management is new. Some of its principles were discovered and applied a quarter of a century ago by Fred W. Taylor in the Midvale Steel Works. Other principles have been discovered and developed by him and by many others since. It was not until the publication of his essay on " Shop Management " in 1903 that the results of his work and that of his associates, particularly H. L. Gantt and C. G. Barth, were presented to the public in a comprehensive form; and it is scarcely more than three or four years since these principles developed into a science. Emerson on " Efficiency " and " Going's

" Santa Fe Management " were published in 1909; Gantt's " Work, Wages and Profits " in 1910.

GANTT (Record, p. 3452).

"Mr. BRANDEIS. And when would you say the different principles which were involved in the works management had sufficiently developed to be entitled to be, as it were, brought together into a body which might be termed science?

Mr. GANTT. That is very recent; not more than three or four years at the most."

(Compare TOWNE: Record, p. 3287.)

1. *Scientific Management is not merely Competent and Progressive Management*

The demand for scientific management and the high degree of efficiency and economy which go with it is not to be interpreted as a general charge of incompetency on the part of the present managing officials of the railroads or of their subordinates. Nor is it merely a demand for what is commonly known as progressive management. Scientific management differs radically from the most competent and progressive management under the old system. It differs also from systematized management. The difference is one in kind; and not merely in the degree of competence, or in the existence of progressive as opposed to conservative methods. Scientific management differs from that now generally practised by railroads, much as production by machinery differs from production by hand; and the revolution in railroading and other industries, which must result from the introduction of scientific management, is comparable only to that involved in the transition from hand to machine production.

(*a*) GANTT (Record, pp. 3454–3456).

"Mr. BRANDEIS. I wanted, just before going into specific matters, to ask whether you will distinguish between what is understood as

unsystematized business, and a systematized business, and scientific management; those three different classes.

Mr. GANTT. I think I have had some experience with all three kinds. The unsystematized business is where the order is issued from the office to the shop, and the office feels that their entire responsibility ends when they have issued the order to the shop. They feel no responsibility whatever until the date on which they wish that goods to be shipped passes, and then they feel that it is their duty to go out and raise row with the shipping clerk, first, and then with the one the next higher up, and then with the one the next higher up, and so on until they get as far back as possible. That is the unsystematized business.

The systematized business or manufacture is where they have a regular routine by which these orders shall proceed, from the office to the different departments, through to the shipping department, and in many cases they have a proper sequence worked out, so that the method of filling the order is not entirely left to the subordinates. That is the first step from the unsystematized to the systematized business; that is a step in the right direction, as everybody will admit.

The scientific management comes when each of those steps has been thoroughly investigated, each of the steps through which the work shall proceed, from the point at which it originates, to the point that it comes out of the works, when each of the steps has been investigated by the best expert available, be it a mechanic or whatever other person he may be. When that has been done, when each of those steps through which the work has progressed has been studied in detail, and a specific, definite route has been laid out, reduced to writing, and the returns come to the office to show how this work has progressed each day, from the time it is issued from the office; and when any failure to live up to these instructions is immediately reported back to the office, and a proper person who knows how it should be done goes out and helps the work along — does not wait until it is three or four or five days late and then go out and make a row — but as soon as it is one day late, he goes out and tries to remove the obstacle so that it can proceed, and perhaps catch up with the other work that has gone before it — that is scientific management. That is the difference between scientific management and the systematized management.

In the systematized management, the responsibility has not been

fully developed, as I take it, to see that each person is proceeding with the proper means whereby he is to get this work through."

(*b*) EMERSON (Record, pp. 3530–3531).

"Mr. BRANDEIS. What is the distinction between what you call scientific management and system or systematizing of business?

Mr. EMERSON. Recently in writing a letter to a correspondent I told him that if he got his breakfast every morning at exactly the same hour and served in exactly the same manner, with the same knives and forks and spoons, in the same place, that might be system; but that if I took him out into the woods and made him tramp twenty miles, with forty pounds on his back, and pitch his own tent at night and cook his own meals, if I succeeded in restoring his shattered constitution that would be efficiency engineering. (Laughter.)"

2. *What Scientific Management Involves*

The action of the efficiency engineer working under scientific management has been aptly compared to a machine. He considers a business as an intricate machine. He analyzes each process into its ultimate units, and compares each of the smallest steps of the process with an ideal of perfect conditions. He then makes all due allowance for rational and practical conditions and establishes an attainable commercial standard at every step. Then he seeks to obtain continuously this standard, involving both qualities and quantities, — the interlocking or assembling of all these prime elements in each process into a well-built smooth-running machine; and when there are, as usual, several processes in each department and several departments in the business, all the departments as well as all the processes must be co-ordinated, so that the machinery of the whole business works with equal smoothness.

Engineering, whether applied to the production of transportation or of cotton cloth, or shoes, or machines,

means the planning in advance of production so as to secure certain results. The distinction between the mechanic and the engineer is that the mechanic cuts and tries and works by formula based on empiricism; the engineer calculates and plans with absolute certainty of the accomplishment of the final result in accordance with his plans which are based ultimately on fundamental truths and natural science.

In scientific management, therefore, results are predetermined. Before the work is commenced, it is determined not only as to what shall be done, but how it shall be done, when it shall be done and what it shall cost.

EMERSON (Efficiency, pp. 102–103, 104–105).

"There are two radically different methods of ascertaining costs: the first method, to ascertain them after the work is completed; the second method, to ascertain them before the work is undertaken. The first method is the old one, still used in most manufacturing and maintenance undertakings; the second method is the new one, beginning to be used in some very large plants, where its feasibility and practical value have already been demonstrated.

The objections to the old method are not only that it delays information until little value is left in it, but that it is wholly and absolutely incorrect, mixing up with costs incidents that do not have the remotest direct connection with them, so that analysis of cost statements as, for instance, repair costs per locomotive mile, does not lead to elimination of wastes. The advantages of the second method are not only that costs must be ascertained before the work is begun, but that the costs as finally tabulated are the real costs divided as to each unit, whether a single element or aggregated out of a million separate elements (1) into standard expense and (2) into avoidable loss. An analysis of costs so stated facilitates an almost inexorable elimination of inefficient conditions of all kinds, standard expenses being constantly standardized at new levels — wastes, the excess above standard cost, being constantly removed....

Predetermination of results is the main characteristic of the modern method. The acceptance of the hap-hazard is the main characteristic of the old method, still in full and orthodox standing

in cost accounting. Predetermination of results is based on scientific certainties modified by experience. It ought not to be necessary to prove that retrospect costs based on servile record of the haphazard cannot be of value, but actual illustrations from actual practice of their unreliability may hasten the conversion of those who are still skeptical.

Two closely similar types of locomotives were operating on a great railroad, one type in the East, the other in the West, both doing virtually the same work. The vice-president of the road desired to order a large number of new locomotives of the general type in question. He called for the records of the two classes and found that the locomotives operating in the West cost $0.14 per mile for maintenance, but that the locomotives in the East cost $0.10 per mile for maintenance. With these records before him he felt inclined to order the type costing for repairs $0.10 per mile. The facts were, however, that the Western round-houses and repair shops were operating at 50 per cent efficiency, and the Eastern shops and round-houses at 80 per cent efficiency, so that the real respective costs of the locomotives were for the Western $0.07 per mile and for the Eastern $0.08 per mile. In this case so-called actual costs would have been expensively misleading. . . .

There was a railroad shop in which charges were distributed with such painful care that the shop sweepers subdivided their time to the various locomotives around which they loitered. But locomotives, as well as men, can loiter, and one of the locomotives stood in this shop three months waiting for a steel deck plate. Being Familiar with its number, the workers charged all the time they could not readily account for to this locomotive, so that at the end of three months the total amounted to more than $5,000. The fictitious accuracy as to the sweepers' time made more glaring the gross falsity of the locomotive charge. In principle there is no difference between charging an hour of wholly wasted time to a locomotive and charging it with two hours of time when one hour should have accomplished the work. The moment specific wastes of any kind are charged to a definite order instead of being charged to some inefficiency account, real costs are vitiated."

8. *Scientific Management Demands the Separation of Planning from Performing*

Planning in advance is of the essence of scientific management. The business engineer makes his plans and specifications covering the process of production before it is entered upon, — extending his directions like the mechanical engineer into minute details in order to secure the perfect product. Those engaged in actually performing the work would rarely be competent to do such planning; but even if competent, they could not undertake that function while engaged in performance without seriously impairing the progress of the work.

GILBRETH (Record, pp. 3405–3407).

"Separate the planning from the performing. Put that in writing in the form of an instruction card, so that you have it, not in accordance with the description in a cook book, but still more than that, so that each element of the operation which has been determined and standardized is written down in detail that will make a man sick that does not understand the purpose of it." He says: "That is the way these scientists have found out that this can be done the best." That instruction card can be depended upon to carry the word of the master or the manager without a line of translation in the way of the human element. I did not believe any of this, and when Mr. Taylor said to me, "Mr. Gilbreth, it is a shame that a man as strenuous as you are cannot be converted," I said, "When you tell me you can get my men to do three times as much work, you do not know what you are talking about. When my men go home at night, their first inclination is to sit down and rest. I have the best management there is anywhere on getting work out of men." That is the way every man talks to Taylor, and nearly all of his time is taken up trying to convert people that know an awful lot about military management, and do not know anything about functional foremen management.

By degrees I took some of his advice and tried it. I have absolutely revolutionized the trade of bricklaying. Mr. Towne said, "The man that can see the end in the advance of scientific management shows signs of decay." That does not begin to tell the story.

I have thought by revolutionizing bricklaying I had reached the limit of it. I cannot prophesy the end. There is no end. As every other science progressed, this science of the handling of workmen is progressing."

The planning department becomes highly developed.

HATHAWAY (Record, p. 3035).

In the Tabor Manufacturing Co. there were only seventy-five persons working in the machine shop, and twenty in the planning department.

The work of the planning department in the Brighton Mills is thus described:

SCHEEL (Record, pp. 3358–3362).

"Mr. BRANDEIS. You said, Mr. Scheel, you were the head of the planning department. I wish you would describe or state what that planning department consists of, who the members are, and their various functions.

Mr. SCHEEL. The planning department consists of those of the staff of the factory. It consists of the routing clerk, a cost clerk —

Mr. BRANDEIS (*interrupting*). You are the head?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. You are called the head?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. What is the next person?

Mr. SCHEEL. The man sitting next to me is the cost clerk or the cost accountant clerk. He is assisted by a cost clerk, who works up the preliminary figures for him.

Mr. BRANDEIS. What does the cost clerk or the cost accountant do?

Mr. SCHEEL. The cost accountant draws conclusions from time cards, store cards, memorandum of the cotton used and the distribution of expense to the different kinds of fabric and accounts generally.

Mr. BRANDEIS. He is currently keeping daily the cost of the article produced, is he?

Mr. SCHEEL. Yes, so that some result may be attained. The fundamental figures are worked up daily. The results are worked up monthly or every six months.

Mr. BRANDEIS. Next to the cost accountant is the cost clerk. What is the next person?

Mr. SCHEEL. The routing clerk, for the latter portion of the mill.

Mr. BRANDEIS. Is there more than one routing clerk?

Mr. SCHEEL. Yes, there are two routing clerks. There is one for the weaving room and the departments allied to it —

Mr. BRANDEIS (*interrupting*). The finishing?

Mr. SCHEEL. The finishing and the warping and winding, where the warps are prepared and where the filling is prepared. The other routing clerk directs the manufacture as to kind in the card room and spinning room and twisters.

Mr. BRANDEIS. What does the routing clerk do?

Mr. SCHEEL. He keeps a schedule showing what work is in process and what work is planned for.

Mr. BRANDEIS. That is, he makes up really the time table, does he, of all the work as it goes through these eighteen different departments?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. And there are stations at which they are due right through these departments?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. And he is keeping all the time records as to just what there is at each station as it comes along?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. Whether it is on time or overdue?

Mr. SCHEEL. Yes, or ready in preparation.

Mr. BRANDEIS. What is the next official?

Mr. SCHEEL. There is a balance-of-stores clerk in the office.

Mr. BRANDEIS. What does he do?

Mr. SCHEEL. All stores are issued on cards, cards showing the taking out of stores. All receipts and all orders pass through his desk. He keeps the tonnage balance of materials in stores.

Mr. BRANDEIS. He is the one who keeps account of just what there is at all times, so he may determine what there should be?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. The next one is what?

Mr. SCHEEL. The time keepers. There are four of them. They work up the time cards. Their work is finished when the entry is made on the pay roll, and the entries for the day on the pay roll checked.

Mr. BRANDEIS. What next?

Mr. SCHEEL. There are the investigators.

Mr. BRANDEIS. How many of them are there?

Mr. SCHEEL. There are six.

Mr. BRANDEIS. Six investigators, and what are their duties?

Mr. SCHEEL. They are engaged in investigating problems in various parts of the mill, all the time studying and working in the training of the workmen to bring them up to the standard. That about covers it, I think.

Mr. BRANDEIS. The gang boss is doing the training of the workmen, is he not?

Mr. SCHEEL. Not initially, necessarily, but the gang boss does that currently. When a thing is once established, the outside people keep going, but the investigator is a superior brain that gets it started and makes the preliminary studies and investigation."

4. *Scientific Management Changes the Relations of the Management to Labor*

Under scientific management, the management of the business assumes towards the workmen a wholly new function. Instead of the prevailing "putting it up" to the employee to do his work with such stimulus as may be given through force or inducement, the management, under the new science, assumes the responsibility of enabling the employee to work under the best possible conditions of perfect team play. It undertakes to instruct him definitely what to do and the best method of doing the particular work. It undertakes to provide him with the best tools, and with machines in the best condition. It undertakes to furnish him with assistance to perform those parts of the operation requiring less skill than his own. It keeps him constantly supplied with appropriate material. Acting in full co-operation with the workmen, the management thus removes all obstacles to the work-

men's full performance and supplies all aids necessary to secure full performance. The management thus assumes the burdens of management, and relieves labor of responsibilities not its own. It substitutes functional or staff organization for the military system.

EMERSON (Record, pp. 3588–3592).

"Mr. BRANDEIS. Just a word. Something was said about the military organization being objectionable, and the need of a staff organization essential to scientific management. If you can, in a word, state what you mean, or what is meant by that.

Mr. EMERSON. I would like to relate a little experience that will illustrate what I mean. In the old type of shop the vice-president of a railroad appoints the superintendent of motive power; the superintendent of motive power may select a shop superintendent; he may select his foreman; the foreman may select the man, and the doing of the job is delegated to the man.

A casting that ought to be machined in three hours will come in, and it is a very hard casting, and it takes twenty hours to machine it. The man is entirely contented. It is easier for him. He does not have to set up other castings, and he stays there and watches his machine take off these fine, hair cuts, and the twenty hours are taken up in machining that casting.

That is the old method.

Under the new method, we reversed that, in theory, as far as we could. Our theory was that it was the machine that did the work; that the man was there for the sake of the machine; that the foreman was there for the sake of the man; that the superintendent was there for the sake of the foreman; that the president was there for the sake of the superintendent; and in that way that the machine could call on the vice-president in case it got into any difficulty. That was the type of organization.

It requires nothing revolutionary to bring that about, except an entire change of view.

In this particular shop they had scheduled the work at three hours. The man tried his casting, and it took him twenty-three hours to machine it. He was losing out on his efficiency; he was naturally losing his efficiency reward, and he set up a yell to the foreman, "Look at this outrageous thing here, giving me three hours

on that thing. And it takes twenty-three hours to do it." The foreman was losing his efficiency on the man. He came around, in a hurry, to see what could be done to help out that casting, and to see whether the machine was at fault, and found that he could not do anything, so he hustled up to the superintendent, and said:

"Bill is very dissatisfied. It has taken him twenty-three hours to get out that work, that he would ordinarily do in three hours, on an ordinary casting, and I am dissatisfied, and we do not think it is a fair deal. It is not a right thing. What are you going to do about it?"

The superintendent went up and investigated, and said: "I will anneal those castings" — there were thirty-five of them. "I will put them in the big flange furnace, and anneal them, and soften them."

So he did put them in the big furnace, and tried to anneal them, and soften them, but there was manganese in the steel, and it did not soften. So that it was just as hard as ever.

He had exhausted his resources and came up to me and told me the trouble. He said: "What would you recommend doing?" He said: "I have done everything that I could." I said: "The proper thing to do is to have a special time study made for those thirty-five castings. They are special castings, much harder than normal. You have an entire change of conditions. Go in and make a new study, and make it date back to the first casting that the man had." So a new study was made, under the superintendent, by this time-study man, and the time was settled for these particular castings of twenty hours. The man, after that, attained his twenty hours, and he was contented. The foreman was contented.

I said to the superintendent: "You don't get out of it so easily. You are going to be charged up with the seventeen hours' loss on each one of those castings. That is pure waste and should not have occurred." He said: "What could I do about it?" I said: "You should never have let hard castings like that come into the shop." What are you here for, if you don't look at your material as it comes in?" He said: "What can I do about it?" I said: "Go and kill the purchasing agent." He said: "I will do it. I will write him a letter." So he wrote a letter to the purchasing agent, and I wrote a letter to the vice-president, calling his attention to the matter, and it was taken up with the steel foundry company that supplied the castings, and a complaint was made that they were furnishing castings with manganese in them, that were too hard, and that that condition

would have to be rectified; that the road would not receive castings of that kind, or it would charge the extra amount of work up to the foundry that furnished them.

That system resulted in making the vice-president remedy a difficulty that otherwise might have lasted indefinitely and greatly added to the expense of the operation.

Mr. BRANDEIS. And that would also have detracted from the reputation of the workman who did the job?"

5. *Scientific Management Demands Preparedness*

The results attained through scientific management depend upon universal preparedness. Under scientific management nothing is left to chance. All is carefully prepared in advance. Every operation is to be performed according to a predetermined schedule under definite instructions, and the execution under this plan is inspected and supervised at every point. Errors are prevented instead of being corrected. The terrible waste of delays and accidents is avoided. Calculation is substituted for guess; demonstration for opinion. The high efficiency of the limited passenger train is sought to be obtained in the ordinary operations of the business. The same preparedness is invoked for industry which secured to Prussia her victory over France and to Japan her victory over Russia.

HATHAWAY (Record, pp. 3039–3048).

"Mr. BRANDEIS. Will you now describe what you did with a view of preparing the way for the twenty men who were to functionalize this business?

Mr. HATHAWAY. We first installed a tool room and equipped it with tools. We arranged storerooms for the proper handling and storage of materials, and a planning department equipped with the necessary paraphernalia for doing the planning, planning the work. Planning the work consists of taking the drawings for any given job,

and from them mapping out in advance a definite course of procedure for prosecuting the work. Formerly the drawings were turned over to the foreman in the shop and his clerk ordered the castings and materials, and when they came in he planned it as well as he could or left it to the workman to plan out in case he had not time. As it is now, no piece of work is started in our shop until the method to be followed in prosecuting it has been completely mapped out. We determine in advance just how the machines shall be built, just what operations shall be performed on each of the parts that enter into that machine, and what machines they shall use in the sequence of the operations. We take each operation and plan the best method for doing it, and the tools that shall be used, and also as we do that we determine the time that that operation should take in its performance. The materials are all ordered in advance, before the work or the order goes into the shop at all, and the planning is going on during the time that the materials are being gotten into the shop. When the work is started in the shop, every possible preparation has been made, everything has been anticipated so far as possible to do it.

Mr. BRANDEIS. That is, when the work first enters the shop for the first piece of work to be done on it, you have prepared everything that is to follow in precisely the same way that the mechanical engineer has prepared everything when he is building a bridge or a steel structure or the like?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. And that applies to every single operation in the process of manufacture?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. As it goes through your plant?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. So that the planning is entirely comparable to the planning of the mechanical engineer who is constructing a bridge or a ship or any similar structure?

Mr. HATHAWAY. Precisely, yes.

Mr. BRANDEIS. In planning that work will you describe just the steps and the different functions of these twenty men that you speak of and what they are doing?

Mr. HATHAWAY. As soon as the drawings have been prepared —

Mr. BRANDEIS (*interrupting*). That preparation of drawings is precisely the same under the new system as it was under the old?

Mr. HATHAWAY. Precisely, excepting that our drawings now con-

vey the information necessary for the manufacture of goods a little more clearly than formerly.

Mr. BRANDEIS. It has certain additional instructions to the workmen?

Mr. HATHAWAY. Yes, and the planning appears more clearly.

Mr. BRANDEIS. But aside from that, there is no appreciable difference in the drafting room?

Mr. HATHAWAY. No.

Mr. BRANDEIS. What takes place when it goes into the manufacturing department?

Mr. HATHAWAY. The first step is to prepare a diagram or chart — that is, providing it is a machine composed of a number of parts — showing the relation of the various parts to each other, their relative importance, so far as they are to be pushed through the shop. For instance, a part that takes longer to get the casting for and has more operations, or operations of a more intricate nature on it, which we regard as being more important than a simple part that has one or two operations on it, is pushed through the shop, and this diagram indicates that and shows its relation to the other parts.

Mr. BRANDEIS. As I understand it, when the original planning is made, you are providing in advance or determining in advance those portions of the machine which it will require a longer time to get ready?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. So that when the period of manufacturing arrives, when they are needed, they will be ready to go forward on the train of manufacture?

Mr. HATHAWAY. Yes. This diagram shows the materials required for each of the various parts, the relation of the parts one to another, the operations to be performed on each of the parts, and which parts are to be manufactured especially for the order in question, and which can be drawn from stores or from stock. At that time what we call route sheets are made up on which the progress of what work we are sending through the shop is later kept track of. Orders on the storeroom for all material to come from stock are made up.

Mr. BRANDEIS. Take this route sheet which comes in at the beginning. Is there a predetermination approximately of the date when every bit of work on this order is to be performed?

Mr. HATHAWAY. Approximately there is. There is a date fixed for the completion of the entire lot of machines, and from that we

work backwards and fix dates when the various groups of sections of machines should be completed.

Mr. BRANDEIS. In the planning?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. In the planning there is fixed a time schedule?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. When the work, or each particular piece of the work, must be completed?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. In order that the train may arrive on time?

Mr. HATHAWAY. Yes. That, however, is not done by the man who plans the methods for doing the work. It is a different man, a different function.

Mr. BRANDEIS. It is a diffierent man who does that?

Mr. HATHAWAY. Yes. That is the first step in the planning. After this diagram or these diagrams have been made up the next step is to see that we either have in stock all of the materials required, or that we have them ordered. The castings are ordered by a clerk whose duty it is to see that the castings get in on time, and who is in constant touch with the founderies, and it is his duty to see that the castings get in when wanted. The materials that are ordinarily carried in stock or in the stores are looked after by a clerk whose duty it is to see that the stock of standard articles, such as cap screws, bolts, bar steel and raw materials of that sort, is kept up.

The next step after that is to plan in detail the various operations, and in doing that the clerk whom we call the instruction card man gets the drawings for each piece and studies that particular operation and writes up an instruction card, stating the best method and the method which should be followed in performing that particular operation.

Mr. BRANDEIS. These men are among your functionalized twenty?

Mr. HATHAWAY. Yes, sir.

Mr. BRANDEIS. These men determine from the drawings the best way of performing every operation required in the construction of the machines?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. And they reduce it to writing?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. The instructions for performing that operation are reduced to writing by them?

Mr. HATHAWAY. Yes. They describe the method to be followed in performing that operation, in just the same way as they would do if they were going on the machine to do it themselves, and as they do that they at the same time make up a list of tools required for doing this operation in accordance with the method they have planned.

Mr. BRANDEIS. Are there any other instructions that are given?

Mr. HATHAWAY. Those are the principal instructions.

Mr. BRANDEIS. Is there any instruction as to the time which shall be required in performing the particular operation?

Mr. HATHAWAY. Yes, I neglected to say that in writing up this instruction card they put down each element that enters into it, such as putting in and taking out drills, putting on clamps for holding the work, changing the feeds and spools — every movement that must be performed is taken into consideration and put down in this instruction card in its proper sequence.

Mr. BRANDEIS. That instruction card will give a definite statement of the thing to be done?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. And the time allowed?

Mr. HATHAWAY. And the time allowed for doing each particular thing or performing that particular element.

Mr. BRANDEIS. And that instruction card is handed to the man who is to perform the work?

Mr. HATHAWAY. That instruction card is handed to the man who is to perform the work for his guidance and for the guidance of his gang boss or machine boss.

Mr. BRANDEIS. What is the next step?

Mr. HATHAWAY. The next step is putting the work in process or starting it out in the shop. I am a little ahead of myself there. In the meantime there have been operation orders written up; that is, an order for each operation, which is posted in the shop, and a bulletin board for each machine. They are written up. The orders for movement of work from place to place are written up. In fact, everything is arranged in advance or prepared in advance. Then the work is ready to be started in the shop as soon as the materials have arrived.

Mr. BRANDEIS. That is, everything that is to be done in the building of this machine is provided by specifications in advance?

Mr. HATHAWAY. Has been planned and prepared for.

Mr. BRANDEIS. So that the different pieces of work are assembled from time to time just as if you had completed the machine?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. Now go forward.

Mr. HATHAWAY. When the work is started in the shop, as soon as the materials arrive in the shop — we will assume we have some castings coming in ordered shipped for these machines or for a given machine. When they arrive, a notice is sent to the planning department and the clerk whom we call the recording clerk gets that notice. He immediately takes from the orders which have been written in advance and which have been placed in a receptacle, one of those orders and hands it to the move man, a man who does nothing but move the material. He does nothing except on written orders."

6. *Scientific Management Demands Analytical Study*

The results attained through scientific management depend further on a careful study of each operation with a view to determining in the first place what time should normally be taken in performing the operation, and secondly, whether it can be performed in a better manner than has hitherto been practised. No assumption is made that the time hitherto employed was necessarily the proper time, nor that the way in which it has been performed is the best way. Scientific observation and scientific methods are substituted for the rule of thumb, for practices hallowed by age and tradition; and waste, whether of time or of effort or of material, is eliminated. The whole realm of science is brought to the aid of the humblest workman. Instead of letting him trudge alone in darkness and afoot through a sandy road, he moves as on a bicycle by daylight over asphalt pavement.

(*a*) GANTT (Work, Wages and Profits, pp. 30–31).

"We can never be certain that we have devised the best and most efficient method of doing any piece of work until we have sub-

jected our methods to the criticism of a complete scientific investigation. Many people who have been accustomed to seeing an operation performed in a certain way, or to performing it in that way for a number of years, imagine they know all about it, and resent the intimation that there may be some better way of doing it. Anybody, however, who carefully analyzes the sources of his methods will find that the mass of them are either inherited, so to speak, from his predecessor, or copied from his contemporaries. He will find that he knows but little of their real origin, and consequently has no ground on which to base an opinion of their efficiency."

(*b*) GANTT (Work, Wages and Profits, pp. 34–36).

"The first condition is an investigation of how to do the work and how long it should take. The fact that any operation, no matter how complicated, can be resolved into a series of simple operations, is the key to the solution of many problems. Study leads us to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study.

This is recognized at once as simply the ordinary scientific method of procedure when it is desired to make any kind of an investigation, and it is well known that until this method was adopted science made practically no progress. The ordinary man, whether mechanic or laborer, if left to himself seldom performs any operation in the manner most economical either of time or labor, and it has been conclusively proven that even on ordinary day work a decided advantage can be gained by giving men instructions as to how to perform the work they are set to do. It is perfectly well known that nearly every operation can be, and the actual work is, performed in a number of different ways, and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method.

To analyze every job and mark out instructions as to how to

perform each of the elementary operations requires a great deal of knowledge, much of which is very difficult to acquire, but the results obtained by this method are so great that the expenditure to acquire the knowledge is comparatively insignificant."

(*c*) GILBRETH (Record, p. 3416).

"I am frank and glad to say that this subject has become so exceedingly interesting to me that not only from the standpoint of interest, but from the standpoint of actual profits and benefits to my business, I am spending one day in every two weeks in some shop where there is scientific management. I am learning my trades all over again. I find the way I have always done has been wrong, and I am of the opinion that any new problem that comes up that has not been attacked by the laws of scientific management, is wrong, is bungled, and is very badly bungled."

(*d*) SCHEEL (Record, pp. 3334–3336).

"Mr. SCHEEL. One of these new looms, in fact four of them, had been studied by a man especially deputed to do that work; that is, a time study had been made.

Mr. BRANDEIS. What were the qualifications of that man who made the time study?

Mr. SCHEEL. He was the best man available; the best man as to experience; he was a college graduate, and also a graduate of Stevens Institute, who had been with the Brighton Mills in their mechanical department up to that time, for two years, I think.

Mr. BRANDEIS. When you say he studied the operation of that machine, describe exactly what he did, what studying means.

Mr. SCHEEL. In his case, I think studying meant, as the machine was being operated by a very good man, seeing what the difficulties were that prevented that man doing better work than he was doing.

Mr. BRANDEIS. You say, what the difficulties were in determining how that man could do better than he was doing?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. How long did it take for this expert to study that simple operation?

Mr. SCHEEL. I think he spent a month, taking his notes, getting his readings, getting together his ideas regarding what the difficulties were, and thinking how he could remove them.

Mr. BRANDEIS. That is, he spent one month in the study of that particular operation?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. And what was it that he did, and why did it take him a month to study that operation? Was he studying any improvement in the operation itself?

Mr. SCHEEL. No.

Mr. BRANDEIS. What was he trying to do, during that month that he spent his time on that study?

Mr. SCHEEL. He was trying, in the first place, to remove difficulties.

Mr. BRANDEIS. That is, to eliminate obstacles to progress in the work?

Mr. SCHEEL. Yes; and also to determine what physical motions the man went through, what the reasonable times were for each part of each of those motions, and what interferences there were in the way of the machine time itself. That is, what was preventable, plainly, and what was not preventable."

7. *Scientific Management Demands Records of Industrial Performance*

Scientific management recognizes also that due appreciation of the actual results of effort must be based upon actual knowledge; and such knowledge is an essential condition to the best performance. The current record of the accomplishment of each individual, of each machine, and of all material is an indispensable factor in scientific management. Without such a record the tyranny of the foreman, and all the discord which attends it, is inevitable. Without such a record justice to employer and employee is impossible. Without such a record waste cannot be eliminated. Without such a record no firm basis exists for progress in the individual or in the establishment.

Possessing such individual records, each performance is then compared with the standard determined through analytical study.

(*a*) GANTT (Work, Wages and Profits, p. 64).

"Not long ago a large contractor in New York, who had been studying methods of handling his workmen efficiently, spent some time on one of his large excavating jobs. He provided a sufficient number of buckets so that each man was always shovelling into a bucket by himself, and kept track of the buckets filled by each man. At once the number of buckets that came out of the hole was doubled."

(*b*) SCHEEL (Record, p. 3329).

"Mr. BRANDEIS: And what result is there in respect to the method of stores keeping?

Mr. SCHEEL. It involves the use of a systematic way of ordering materials; the use of the requisition from the man that wants the article on the purchasing agent; the use of a certain form on the part of the purchasing agent when he orders that material; the notification of the man that makes out the requisition when the article is received, so that he may pass on its quality before payment is made; and a notification of the accountants that the item is ready to be paid.

Mr. BRANDEIS. Then there is in this system of stores keeping an exact assimilation of the treatment of materials to that which has been common in the case of the treatment of money, and the vouchers for all the money expended?

Mr. SCHEEL. I should say so, yes.

Mr. BRANDEIS. So that, in determining at any time the materials on hand, instead of taking an inventory, or making a personal inspection, there is merely an inspection of the record to determine what is there?"

(*c*) SCHEEL (Record, p. 3330).

"Mr. SCHEEL. The method of time keeping makes provision for exact knowedge, on separate time cards, of operations — several cards for several operations by the same person, if they take place in one part of the day.

Mr. BRANDEIS. And each card, then, each day, is a record of what the man has done, and what the cost of it is, in wages?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. So that, combining the material, the stores keeping and the time record, there is in the business, at hand, a daily balance showing the exact condition of the business, the exact expense up to that time of the operations which have been performed?

Mr. SCHEEL. Yes.

(*d*) GILBRETH (Record, pp. 3408–3409).

"Mr. GILBRETH. The first thing to be done, I should say, although there are a great many routes leading to this same place, is to separate the work of each man so that his output can be recorded separately, so that the square deal may be given to that man who is really doing the business. You make an incentive then for each man to do his best, and if he is rewarded in accordance with his effort, that is but one of the many schemes whereby this system is founded on fair play to the workman. Record the output of each man separately. Of course the man that hears this for the first time will say, "I know a case where you cannot record each man separately because there are four men pulling on a rope." That is no reason why you should not record the rest of them separately. I know of no shop where the scientific management has gone down and reached the last man. It is a case of percentage. If you can get 90 per cent of your men on this system instead of 80 per cent, it is a great deal better than the 80 per cent basis. That is the first step. Place your men so that their output can be measured separately and measure it separately so as to give the square deal to each man. That is the first step."

(*e*) GILBRETH (Record, pp. 3410–3412).

"Mr. GILBRETH. First of all, we separated the men so that their output showed up separately.

Commissioner PROUTY. Just how did you do that — by giving each man a certain number of brick, or how?

Mr. GILBRETH. That question you have asked, Commissioner Prouty, is a very leading question. It took us a long time to answer that on the work. We could not measure the output of each man separately for a long time. But in the process of scientific management that fact was prophesied, that we would be able to do it as surely as the position of one of the outer planets was prophesied by mathematics. We furnished our men with eighteen bricks in what we called a packet for the want of a better name. That packet consisted of a tray with four slats, two this way and two this way, for handles. I got the idea for that from Mr. Taylor and Mr. Gantt in the matter of handling pig iron at the Bethlehem Steel Company. They found after long experiments that ninety-two pounds was the best unit for handling pig iron. If that is true of pig iron and the

laborer makes no use of the material he carries, it must be true also of brick. So we arranged to have the packet that would best handle ninety-two pounds of brick. We counted the empty packet. We could do it no other way, and I assure you that we were weeks learning that simple fact. We had to knock off all business and put a man specially trained in science to discover how to measure the number of bricks of each man. Every workman, every brick man and foreman on the job, gave it up as being impossible, and that illustrates particularly well the difficulties encountered in this thing, and if you do not know more about your work than the best mechanic you can get it is not scientific management. This eliminates the old practice of safely leaving the conducting of work to a good foreman or a good superintendent. The new management consists of taking the best superintendent you can get, at any price, together with other scientists, and sitting down together and getting the best way, and putting it in writing, then measuring the output of each man and paying him a wage unheard of before. You cannot drive that man away from your job with a club when he once begins to get his bonus."

8. *Scientific Management Demands Standardized Methods and Equipment*

Scientific management seeks to ascertain and apply in every process the best attainable methods, practices, tools, and machines. It necessarily follows that all must be standardized. There is but one best way; and it is essential for the standardization of tools and machines that they be all in perfect condition. Any variation from the best, be it in kind or condition, is certain to interfere with the regularity of production, in quantity and quality and also to render untrustworthy such tests of relative efficiency as have been established.

(*a*) GILBRETH (Record, p. 3409).

"The second step would be to establish standards, standard tools. Go into Mr. Dodge's shop and you will find a man cannot use any

tool he wants. He has to use the standard tool, for they know what is better for him than he knows himself. The secret of this whole thing is that they have brought together the best men from the ranks, from the colleges, from the board of managerial experts, and they have all gathered together and put all this thing in writing, and that is the standard, and each man must use that standard. He must do it in no other way. He must use that standard. They provide a very good way for these better improvements to come in all the time and supersede the others."

(*b*) EMERSON (Efficiency, p. 79).

"The standard study has increased the average life of belting more than six-fold; has reduced belt failures to one-sixth of what they were, and has decreased the known cost to less than one-seventh."

Scientific management of course recognizes the possibility and desirability of such changes in methods, practices, tools, and machines as will tend to advance the art; but no change should be adopted except as the result of careful consideration by those most competent to deal with the subject.

9. *How Scientific Management has Increased the Efficiency of the Individual*

Wherever the principles of scientific management have been applied, greatly increased efficiency of men has been attained. The following are a few examples:

(*a*) When applied to the simple operation of loading by hand a railroad car with pig iron, the performance of the individual worker increased from 12½ to 47 tons a day.

(*b*) When applied to shovelling coal, it doubled or trebled the performance of the shoveller.

(*c*) When applied to machine shop work, it developed in certain operations, increases in production, ranging from 400 to 1800 per cent.

(*d*) When applied to bricklaying the day's accomplishment rose from 1000 to 2700 bricks.

(Gilbreth: Record, p. 3410.)

(*e*) When applied in the manufacture of machinery, 75 men in the machine shop with 20 in the planning department do two or three times as much work as 105 men in the machine shop did under the old methods.

(Hathaway: Record, p. 3059.)

(*f*) When applied in the manufacture of cotton goods, it increased the output a hundred per cent.

(Scheel: Record, p. 3377.)

10. *How Scientific Management Increases the Efficiency of Plant and Equipment*

Under scientific management the same analytical study is made of the possible accomplishment of each part of the plant and of each individual machine, as it is of the individual worker. Analytical study is made to determine what performance is possible under the best conditions and to eliminate every obstacle to full performance so as to secure the full utilization of every part of the plant and equipment. In most cases the increased productivity of the individual workman carries with it increased production of plant and machinery. Every problem incident to plant and machinery receives close study, — for instance, the arrangement of plant and machinery so as to reduce all unnecessary movements of men and material or machinery; equalization of equipment as well as standardization of equipment. A common incident of the introduction of scientific management is the discovery that a plant supposed to have been inadequate proves to be over-equipped.

(*a*) Scientific management applied in the manufacture of machinery, increased the capacity of the plant over 150 per cent.

(Hathaway: Record, p. 3058.)

(*b*) EMERSON (Efficiency, pp. 59–62).

"A head of staff to plan, direct and advise as to everything appertaining to the adjustment of structures, machines, tools, and other equipment to the work in hand. There is very little difference between good handling of equipment and good handling of men. The rules that apply to the one case will generally apply to the other. Much has been learned about the proper care of men from methods evolved for the care of equipment, and much has to be learned about the care of equipment from methods evolved for the guidance of men. It is not to be forgotten that in the human organism the whole is incapacitated by a seemingly slight injury to a single part. No man will work efficiently with a cinder in his eye, or a splinter under his nail. Neither will a plant work efficiently if little things go wrong. Single items of equipment are often of very great perfection, whether a Corliss engine or a twist drill, but from twist drill to general design and equipment of plant everything is usually wholly out of relation and balance. Recently, in consequence of staff organization, it was found necessary to relocate over three-quarters of all the machines in two large and fairly modern plants. Each machine had been doing good work by itself, and no one looked further; but the moment its relation to other machines or to the progress of the work was investigated, the conditions at once appeared impossible and unbearable. This relocation of machines, together with other staff reforms, has resulted in an increase of output of 40 per cent without additional men for equipment. The high officials of every railroad point out the glaring defects of early location or equipment — the fact, for instance, that among 1600 locomotives owned by one road there were 250 different types, instead of 6. The earlier builders had no staff advice.

This staff line in charge of the use of equipment also extends down until it is within reach of the worker. An example will show both the nature and the effects of staff organization. A staff was organized on a transcontinental railroad to advise generally as to the care and operation of shop machinery and tools. The duties of the staff, which extended from the vice-president's office downwards, were:

a. To secure suitable machines and equipment.

b. To give them the best possible care.

c. To give the workers advice and directions as to how to use the equipment most efficiently.

The expense of maintaining shop machinery and tools on this railroad, for the year 1903–4, was $487,171; the unit cost in relation to output was $10.31. On a competing and largely parallel railroad, working under similar conditions, the cost in the same year was $487,150, and the unit cost, $9.55. As a result of staff activity and control on the first road, by the year 1906–7 total costs had fallen to $315,844, and unit costs to $4.89, but on the other road, where line organization was not supplemented by staff organization, the total costs rose to $638,193, unit costs remaining virtually constant at $9.81. This saving in expenses of $322,000 was brought about by a staff costing less than $10,000, and the $10,000 is included in the $315,844.

One subdivision of this maintenance problem was the care of belting. This had cost (for maintenance and renewals) at one of the main shops about $12,000 a year, and it was so poorly installed and supervised that there was an average of twelve breakdowns every working day, each involving more or less disorganization of the plant in its parts or as a whole. With the authority of the vice-president and in conjunction with the general purchasing agent, the whole subject of belting was taken up. A few general rules were laid down:

a. That there should be accurate and continuous records of installation, repairs, and breakdowns.

b. That the installation and care should be delegated to one trained specialist with full authority and responsibility.

c. That the quality of the installation and operation should be very high.

The worker in actual charge of belts, a promoted day laborer, was given standards, and took his directions from a special staff foreman, only one of whose duties was knowledge as to belts. The foreman had received his knowledge and ideas from the general chief of staff, who had made belts a special study, and this general chief of staff had been inspired and directed by a man who had made a nine years' special study of belts and who was the greatest authority in the world on the subject. The belt foreman had as much of this knowledge at his call as he could absorb, but he in turn was in immediate contact with each individual belt, with the machine it was on and with the worker using the machine. The chief of staff learned as much from the belt foreman as the belt foreman learned from the chief of staff. The belt foreman learned as much from the machinists

as they learned from him. The cost of maintaining belts fell from $1,000 a month to $300 a month, the number of breakdowns declined from twelve each working day to an average of two a day, not one of them serious, and even the few breakdowns were due almost wholly to originally defective installations, such as narrow pulleys, which it was impossible to remedy without unjustifiable expense."

11. *How Scientific Management Increases the Efficiency of Material*

Under scientific management the same study is made and care taken to secure full utilization of materials as of men and machines. Scientific methods are pursued to determine what materials are best fitted for the particular purpose and what their proper cost should be. Only such materials are supplied. The material is guarded with the same scrupulous care as the money with which it is bought. Ledger accounts are kept for each article; whatever is needed must be vouched and accounted for and the material account be balanced as accurately as the cashier balances his daily cash account. Thus what is on hand is always known by the accounts; and waste either in purchase or in use is avoided.

(*a*) EMERSON (Efficiency, pp. 62–63).

"A head of staff as to materials, their purchase, custody, issue, and handling. Subsidiary materials are only too often purchased on the basis of price per pound rather than on basis of cost per unit. This is inevitable, since no one is able to give the purchasing agent any standard as to cost per unit. After materials are purchased, they are frequently given such poor custody that they deteriorate or disappear before being used. They are still more often issued for extravagant and wasteful use. The economical handling of materials is a special art.

In a large steel plant, staff control of handling material reduced

the cost of handling per ton from $0.072 to $0.033, and increased the number of tons handled per man per day from 16 to 57. Here again was the same kind of staff organization, calling down from the top all the most valuable knowledge in the world as to this one subject, working up from the bottom from actual daily contact with changing conditions.

There is no logical difference between money spent on materials and money spent for labor. A brick wall is a combination of labor and of material. Every issue of material, every issue of labor, should be standardized in advance and checked; the same system of accounting and distribution should be used for both labor and material."

(*b*) EMERSON (Record, pp. 3546–3547).

"Commissioner PROUTY. What do you mean by 'inefficiency of material'?

Mr. EMERSON. Engineers know very well, and have determined how much horsepower you ought to get or how much water you ought to be able to evaporate from a pound of coal. If you are using a great deal more coal than that there is an inefficiency. There is an ideal result which you ought to get which would be a horsepower from one-fifth of a pound of coal. The highest attainment they ever get is a horsepower from a pound. That is a very high ideal. If you find people are using either eight or nine or ten pounds of coal per horsepower, it measures a certain amount of inefficiency compared to the practically attainable. That is an illustration. The fuel is the largest single item of expense, so that a large amount of this saving might be from the fuel. That is the second way of determining this waste. The third was the comparative methods. All railroads are efficient in certain directions. They are tremendously efficient in certain directions. Each railroad has some particular spot in which it is more fortunate perhaps than other railroads. Taking the different railroads of the country and visiting them and investigating them and finding out that one had an efficient way as to maintenance of locomotives, another as to maintenance of cars, that a third had an efficient way as to maintenance of shop machinery and tools, and the fourth had an efficiency as to maintenance of track; and taking all these different bright spots that the railroads had evolved through the special genius of the men connected with or interested in those particular departments, you get a third standard —

a standard, for instance, let us say of six cents a mile as being an adequate amount on the average to maintain locomotives, or a standard of thirty-five dollars as an adequate standard to maintain cars."

12. *What Labor Gains from Scientific Management*

A. FINANCIAL GAINS

Under scientific management the employee is enabled to earn without greater strain upon his vitality from 25 to 60 per cent and at times even 100 per cent more than under the old system. The larger wages are made possible by larger production; but this gain in production is not attained by "speeding up." It comes largely from removing the obstacles to production which annoy and exhaust the workman, — obstacles for which he is not, or should not be made, responsible. The management sees to it that his machine is always in perfect order. The management sees to it that he is always supplied with the necessary materials. The management sees to it that the work comes to him at proper times, with proper instructions and in proper condition. The management sees to it that he is shown the best possible way of doing the job; that is, the way which takes least time, which takes least effort, and which produces the best result. Relieved of every unnecessary effort, of every unnecessary interruption and annoyance, the worker is enabled without greater strain to furnish much more in production. And under the exhilaration of achievement he develops his capacity.

1. *Increased Pay*

(*a*) In the Brighton Mills the earnings of wages were thus increased from 45 to 75 per cent above the prevailing day rate.

(See Scheel: Record, pp. 3341–3368.)

(*b*) In the Tabor Manufacturing Company the wages of the men were increased on an average from 25 to 30 per cent.

(See Hathaway: Record, p. 3027.)

(*c*) In the Link Belt Company the earnings of the men range from 25 to 35 over the generally prevailing wage.

(See Dodge: Record, p. 3137.)

(*d*) HATHAWAY (Record, pp. 3056–3058).

"Mr. BRANDEIS. Taking a man at an individual machine, how much does he do under the new system as compared with what he did under the old system?

Mr. HATHAWAY. That is rather difficult to answer, but in general —

Mr. BRANDEIS (*interrupting*). I mean what particular work of producing results?

Mr. HATHAWAY. In general, it ranges anywhere from three to five times the work formerly done. On some machines it is greater as to gain, and on some others there is gain but not so great.

Mr. BRANDEIS. The average would run from three to five times?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. That much greater than what they used to do under the old scheme?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. Is that attributable in large part to his working harder, or is it attributable to other causes?

Mr. HATHAWAY. He does not work any harder than he formerly did. He works more efficiently, however.

Mr. BRANDEIS. And he works more efficiently why?

Mr. HATHAWAY. Formerly, when we started a job, he had first to frequently hunt up the foreman to find out what he would do next. Then he might have to hunt up his materials and get them to the machine. After that he had to decide how the job was to be done and look up his own tools for it. He had to grind his own tools and all of the things that we now do in the planning department for him he had to do himself to a very large extent while his machine was standing idle. As it is now, the machine runs along on other work while we are making preparations for his job ahead. That is one reason.

Another reason is that our machines are in better shape, we furnish the men with better tools, better implements and tools, that are put in condition for us and kept in condition for him.

Mr. BRANDEIS. Then you show him how to do it?

Mr. HATHAWAY. Then we show him how to do it.

Mr. BRANDEIS. Taking that particular work that a man does of three to five times as much as he did under the old system, you have got to set against that the fact that you have these twenty different persons who are undertaking by way of planning or otherwise, instruction or otherwise, to enable him to do it?

Mr. HATHAWAY. Yes."

2. *Promotion.*

GANTT (Record, pp. 3462–3465).

"If I may add here, this instructing of these men rapidly leads to a number of them coming to the front. We get from our men who have been taught, men who have worked at routine work according to their own ways for years, and who have never thought of investigating anything better, — we get from these men, when we begin to instruct them, and they have the inspiration of the higher grade man who is helping them, and not driving them, the material for more responsible positions. We find that those men come forward with suggestions that will help the whole thing along, and they become instructors. We get our best instructors from the men who have been instructed by us. And invariably, in plants where I have been, where they have told me that they did not have any good men in their plants, after we began this system of management, good men began to crop up all around, and in a comparatively short time we had our positions filled with far better men than they ever thought they had there.

Giving the man a chance, giving him inspiration, makes a man out of him, instead of a machine. He has the same joy and pleasure in his work that the man in the higher position has in his. He has his individual record, as was shown to you on those charts, and he does not like to see a red mark against him. He wants it all black. It gives them an influential feeling among themselves. They feel some importance. I have known, in one case, where these people who had become bonus workers formed a little society among themselves, and it was quite exclusive; nobody who could not earn a bonus was allowed to join. (Laughter).

Mr. BRANDEIS. How is it in shops as to avenues of promotion? Do people have a chance to rise up? You spoke of one particular promotion.

Mr. GANTT. I might give one particular promotion, which I think is one of the most striking cases that I have had anything to do with. When I began to do some work with the Brighton mills, five or six years ago, I do not remember exactly how long it was, there was in their shipping department a man named Kelly who understood what I was talking about, and who, in a very short time, saw what we were trying to do, what we were driving at. He had been foreman of the shipping department for fifteen years, during which time superintendents of that mill had come and gone, one after the other, and during that time they had not had any single superintendent who was a really satisfactory man.

In a short time Mr. Kelly was promoted from the position which he held to another one, and then to another one, and within three years or about three years he was superintendent of the mill; and he is a most excellent superintendent. I want to say that but for this system of management it is probable that he would have been there another fifteen years without being promoted to the position of superintendent. I have no reason to believe there would have been any change.

We have had that same thing in another plant, a very large plant, the Sales Bleacheries, where they told us that they did not have any competent and capable man in the place. When we got this work going, we found competent and capable men developing all along the line. And now, I venture to say, they will never, as long as the present management or the people in authority there continue, have to go outside for another man to do anything. They have them all there. I do not mean that they will not have to bring in young men, but I mean that they will not have to bring in men from outside to fill important positions. The men are growing up to those positions, in every direction, within the plant."

B. SOCIAL GAINS

The social gains of the workingman from scientific management are greater even than the financial. He secures the development and rise in self-respect, the satisfaction with his work, which in almost every line of human activity accompanies great accomplishment by the individual. Eagerness and interest take the place of indifference, both

because the workman is called upon to do the highest work of which he is capable, and also because in doing this better work he secures appropriate and substantial recognition and reward. Under scientific management men are led, not driven. Instead of working unwillingly for their employer they work in co-operation with the management for themselves and their employer in what is a "square deal."

(*a*) GANTT (Work, Wages and Profits, pp. 171–172).

"The workman who has become master of something takes pride in his work and soon distinctly improves in personal appearance. The improvement is so universal and so marked as to be always distinctly recognizable, and is much more than can be accounted for by the increase in wages which enables him to dress better.

This improvement is even more marked in girls than in men, for the girls invariably acquire a better color and improve in health. In one case the girl bonus workers formed a society and adopted a badge which they all wore. Only those who could earn their bonus were eligible. This incident is a little thing of itself, but it shows the feeling that comes with the mastery of some subject. They know what they can do and are proud of it. This consciousness of efficiency, — this knowledge that they have succeeded and can do it again, puts the worker in a different class from those who go along day after day watching the clock, and doing just enough not to get discharged.

The task gives the worker a definite object to strive for, causes a certain amount of mental exhilaration, and invariably increases the keenness of the perceptions.

From our task workers we frequently get instructors and sometimes investigators. From our investigators and instructors we get an ample supply of superintendents and foremen. The foremen and superintendents trained under this system have proved far more successful than any it was possible to hire."

(*b*) GANTT (Work, Wages and Profits, p. 116).

"The general policy of the past has been to drive, but the era of force must give way to that of knowledge and that the policy of the future will be to teach that to the advantage of all concerned."

(c) SCHEEL (Record, pp. 3374–3376).

"Mr. BRANDEIS. Have you observed in connection with this any change in the attitude of the men or women in the employ of your company, or of their general demeanor in relation to their work and their attitude toward it?

Mr. SCHEEL. I think quite decidedly so, in several departments.

Mr. BRANDEIS. And in what respect have you observed such a change?

Mr. SCHEEL. In the spinning department we have all noticed that with the introduction of a scientific way of measuring work and of paying for it, there has been a change in the spirit of the help from one of a sort of hidden desire to do as little as possible, perhaps, and take advantage of every excuse and every reason for failure to do anything, to a search for real reasons why results are not possible. It has seemed to us that the individual worker has always been pretty high in efficiency as to himself. When there is a day pay, it seems to us that the operative showed a pretty good degree of efficiency, for he did as little as was convenient for him in order to keep on getting that rate. However, when we so do things that by making his efficiency coincide with the firm's measure of efficiency, he is willing to do whatever is necessary in order to get the added reward.

Mr. BRANDEIS. It has been said in regard to some of the work which, I believe, had reference to work in your mill, that it became fashionable to work instead of to shirk work.

Mr. SCHEEL. Yes.

Mr. BRANDEIS. Were there any instances of that, and are you able to show from any of these charts how there came a change in respect to the fashion of working or not working on particular days or times?

Mr. SCHEEL. I think that is shown in the filling winder sheet.

Commissioner LANE. What page is that?

Mr. SCHEEL. That is opposite page 168. At the beginning it took a number of days, as shown by the red spaces at the beginning of the line, for new operatives to come up to the bonus. Those that came on last, all of the last four, made a bonus on the first day.

Mr. BRANDEIS. That is, at first it took a long time before they could get into the spirit, perhaps, or whatever it was that enabled them to do it?

Mr. SCHEEL. Yes.

Mr. BRANDEIS. And later they caught right on to the moving train and made it quickly?

Mr. SCHEEL. Yes. You will notice at the beginning of the sheet that a good many of the red spaces are Mondays; that is, that the Mondays are shown to be days when efficiency suffers, and that toward the end of the sheet that is not true to the same extent.

Mr. BRANDEIS. How was it about work on Saturdays? Was there any marked change in that, or in any other room, in respect to the work on Saturdays?

Mr. SCHEEL. On the spoolers sheet, opposite page 172, Saturday being a short day and the day when the cleaning up was done, that was the day when the spoolers did not bother much to make the bonus?

Mr. BRANDEIS. Did that fashion change?

Mr. SCHEEL. Yes."

(*d*) GILBRETH (Record, pp. 3417–3418).

"One point I would like to bring out this morning in the interest of the consumers or the workmen or the employes or any one you want to think of, is the fact that this is not a slave-driving scheme. It is a scheme whereby, on the other hand, a man has the joy of achievement, the same joy in a modified form that a football player feels when he runs down the field and beats the others. These men are not driven. They do work harder than they do before. Scientific soldiering is entirely eliminated, and there is nothing better for the morals or physique or anything else of the workman than eliminating scientific soldiering — and it is a science, gentlemen, you have no idea of. (Laughter.)"

C. AIDING THE LESS COMPETENT

Scientific management recognizes the right of those less expert in the work to advance to greater efficiency, and the importance to the employer of training his workmen to be competent. It therefore provides through the most practical teachers for careful training of men to work in the best manner and to develop habits of industry instead of letting "the devil take the hindmost" and exposing the less competent to the probability of discharge. It supplies instruction, and offers to the teachers special incen-

tives if they succeed in bringing up the hindmost. The teacher is as prominent in scientific management as in the armies of Prussia and of Japan.

(*a*) A striking illustration of this proposition is furnished by the practices of the Brighton Mills. After the best conditions for weaving had been determined, the work of instructing the individual weavers was patiently entered upon; practically a month and a half was spent by a scientifically trained expert and the gang boss in training three weavers. Not until they had been trained was the instruction of others undertaken; and even after all have been trained, the gang boss never has under him more than twelve men. Not only the weavers, but the gang boss receives a bonus. His bonus is six cents a day for every man who gets a bonus; but he receives the additional incentive for bringing up the hindmost by an increase of his bonus to ten cents a man if all twelve receive a bonus.

Besides these teachers there are three inspectors in the weaving and finishing rooms, who in a sense are teachers; and in addition in this mill, which has only about 600 employees, there are six investigators who "are engaged in investigating problems in various departments of the mill, all the time studying and working in the training of workmen to bring them up to the standard."

(See Scheel: Record, pp. 3336–3367.)

(*b*) GANTT (Work, Wages and Profits, pp. 109–110).

"Under former conditions, the foreman hesitated to teach the workman for fear the latter might learn as much as he knew and possibly get his job. Under the new conditions, the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus for learning and doing what they are taught. It is this feature of the task and bonus system that has enabled us not only to obtain, but to maintain permanently, such satisfactory results. The expert workman who becomes a good teacher soon makes his services valuable, for, by his assistance, we can often make the average efficiency of the shop even greater than his best efficiency was before we began to study the question of efficiency. He learns to remove obstacles which stood in his way when he was a simple workman, and often becomes an expert also not only at removing these obstacles, but at developing better methods to avoid them."

D. THE BONUS

The money reward for the individual workman's high accomplishment is ordinarily and probably most effectively distributed by means of a bonus system; but while the bonus system is rather a common incident of scientific management, it must not be supposed that the bonus system *is* scientific management. The bonus system is apt to do far more harm than good when it is applied otherwise than as a part of the system of scientific management. Apprehension by labor of the bonus system when introduced except as a part of scientific management, is well founded. On the other hand, the bonus system under scientific management has proved itself to be perhaps the most appropriate method of securing to labor its proper reward and perpetuating full co-operation between employer and employee.

When applied in connection with scientific management the bonus system has always these features, among others:

GANTT (Work, Wages and Profits, pp. 110–111).

"1. — A scientific investigation in detail of each piece of work, and the determination of the best method and the shortest time in which the work can be done.

2. — A teacher capable of teaching the best method and shortest time.

3. — Reward for both teacher and pupil when the latter is successful."

E. PIECE WORK

It must not be supposed that the introduction of the piece rate system *is* scientific management, *or even an approach* to it. On the contrary, the existence of the piece rate system often proves the greatest obstacle to the intro-

duction of scientific management. Under scientific management the increase of wage is coincident with reduction in cost, — but under the Erie piece rate system the increase in wages was attended by reduced performance.

(*a*) STUART (Record, p. 2815).

The piece rate system was introduced on the Erie after a great struggle at a cost of about five million dollars (Record, pp. 2738, 3764). Its introduction was later followed by increase in wages, with this result:

"Mr. WADHAMS. What has been your experience with respect to an increase of wages having any effect upon economic advantage to the railroad?

Mr. STUART. There is no increase.

Mr. WADHAMS. You get no more work than you did before?

Mr. STUART. Not as much.

Mr. WADHAMS. So that, from the point of view of the railroads, you consider the increase in wages as a total loss?

Mr. STUART. Yes; absolutely."

(*b*) EMERSON (Record, pp. 3531–3534).

"Mr. BRANDEIS. Would you state what the relation is, as you understand it, between the piece rate system and the system of bonus reward?

Mr. EMERSON. Both of them are forms of efficiency reward. We have always found, wherever we have been, that piece rates were one of the greatest obstacles to the introduction of scientific methods. Wages in my opinion depend on three matters. The compensation of the workman depends on three different elements. He is firstly entitled to his day rate, whether he works or not; that is, because he comes and puts himself at the disposal of his employer. The employer has a right to ask what the equivalent will be of the wages that he is paying the man. If that man gives more than the usual equivalent or more than the equivalent that may be even scientifically determined, that is the individual merit of the man and he should be rewarded accordingly. I therefore always try to keep these three matters entirely distinct.

The first one, that of the rate of wages, is absolutely open to individual or collective bargaining. The question of equivalent can

only be determined by scientific experts. Either the man who pays the wages or the man who receives the wages is competent to determine what the equivalent is. The third point, the extra compensation that should be paid to a man for his special, individualized effort, is again open to collective bargaining. The reason we find piece rates a great stumbling block in our way is that in the first place they disregard the first principle; they do not guarantee to the man a fixed rate. The second reason for finding them a stumbling block in our way is that an efficiency record should be based on standardized conditions, standardized operations, and standardized reports, and to the great number of different principles should be applied first, before you are in a position to put in an efficiency reward basis. If, in the absence of the application of these principles, you wish to establish piece rates, it is absolutely necessary to make that rate high enough to give the man a living wage. In order to get the piece rate in, that rate is made usually very easy and very high. After a man has worked for a while and has himself to some extent standardized the conditions and standardized the operations, and when the management has to some extent standardized conditions and operations, it is found he is getting an entirely unreasonable rate of compensation. He has not put forth additional effort, but these other elements have come in to make the task very easy. Then the management immediately has recourse to the principle of cutting the rate, which leads the workman to retaliate by standing pat. You have then that element of standing pat on the one side and of cutting the rate on the other side, that does not accord at all with scientific management.

The third trouble with the piece rate system is that it puts the responsibility up to the man instead of putting it up to the management. They have put in a rate and told him, "You go ahead; it is up to you; you turn out all you can. We wash our hands of the matter." The consequence is we do not have what I would call scientific management in the piece rate shops.

That is the reason I have always been opposed to it. I consider it the greatest stumbling block that I encounter, and we also always ask as a favor, as a first step toward improved scientific management, that the piece rate basis shall be abolished, and that the men shall be put back on day rates."

(c) GANTT (Record, pp. 3740–3744).

"Mr. GANTT. In the piece work system, pure and simple, we find, in most places where I have seen it in operation, that there is no special effort made to supply the men with the work when they want it. The man may have to wait for something. The foreman, for instance, does not feel that it is up to him; does not feel his responsibility to help that man; and if the man is delayed about something, he says: "Well, I will attend to you after a while."

Commissioner PROUTY. Yours is a system of team work, and his is a system of individual work?

Mr. GANTT. Absolutely. Ours is a system of team work; and the poorest man on the team is to be helped by the man who knows more than he does. That is the essential difference.

And when we obtain knowledge of the best way in which a thing can be done, that knowledge is recorded. Mr. Kent showed you those instruction cards. That much knowledge can never go back. We have taken that little step — it may not be the best that has been done in the country, but it is the best our expert could devise; and that is recorded, and everybody on our list is taught that. The Canadian Pacific Railroad is preparing to send those instructions over the lines into their shops, as soon as they can get a proper list of standard tools in those shops, and see how much good they can do. We try to bring everybody up to the standard, and gradually to raise the standard, and bring everybody with it. We do not raise the standard by a jump, but gradually, so that everybody can reasonably get up to it. We do not find that one man can do a job in half an hour, say, and then turn around and say that all of the other men must immediately do that job in half an hour, when the other man may have been taking two hours for it. We consider that that would be manifestly unfair, and absolutely wrong and unjust to the men. If that piece of work can be done in half an hour, it is possible for the expert to show the men, to teach them, how to do it. In the vast majority of cases, if the man is a normal man, he comes up to our expectations and becomes a better man as a result, — a very much better man. He has more self-respect, and more reliance on himself.

Mr. BRANDEIS. Taking this very matter of the piece rate, that Commissioner Prouty refers to, if a man, for instance, had been earning, ordinarily, $2 a day, at a given number of rates, representing perhaps ten pieces of this work, then, if he makes eleven pieces, he gets $2.20 and if he makes twelve, he gets $2.40 and the like. I

understand your bonus system is a system by which the man has a limit, by making the effort, which means largely by following the instructions; he would get, not $2.20, $2.40, $2.60, or $2.80, but would make the goal every time, if he worked right. He would either get $3 or $2 or $4 a day, or whatever the rate might be.

Mr. GANTT. That is not exactly it.

Mr. BRANDEIS. That is it in part, is it not?

Mr. GANTT. Partly. The difference is this. That we do not allow a man to work piece work — we do not take the green man, at the start, and ask him to work piece work, but we take the green man, and give him the day's wages, until we can teach him how to earn this higher rate, how to come up to this standard; and then, when he has reached this standard, we give him his additional 25 or 30 per cent, and then, whatever he does in addition to that he gets in proportion.

Mr. BRANDEIS. That is, he gets a piece rate, as it were, after he has reached the new standard; then he gets a piece rate?

Mr. GANTT. In other words, it is different work for the unskilled and for the skilled. When the man becomes skilled, becomes practically in the expert class, you might say, then we pay him piece work; but we teach him how, first.

Mr. BRANDEIS. Yes.

Mr. GANTT. And we help him.

Mr. BRANDEIS. And there is no limit to what the man can get?

Mr. GANTT. No.

Mr. BRANDEIS. When he gets into the bonus class, a man can go just as much higher as his ability will permit; and it is actually your experience that men do go very considerably higher?

Mr. GANTT. Yes. If we find men who are capable of going very considerably higher, we do not cut their wages, and thereby drive them out of the shop, but we say: "Here is a man that would make a good investigator for us. He is the man we are looking for," and he is the man we put on the study of these problems. We make him a teacher. If he is so much better than the rest, we make him a teacher. The result is that we get the benefit of those best men for our teachers and instructors, which improves the condition of our shop.

Mr. BRANDEIS. This is so, is it not, that the management having assumed the responsibility, itself by a proper management to bring the man up to the bonus class —

Mr. GANTT. Exactly so."

13. *What the Employer Gains from Scientific Management*

The employer gains not only reduced labor cost due to greater productivity of the workingman, but also those great incidental benefits which flow from improved service, as from greater celerity and greater punctuality in completing work. The employer gains much from the lessened need of plant and equipment which follows its fuller and uninterrupted use. He saves in interest and taxes, and in depreciation charges. He saves in reduced stock of materials, raw and in process. He saves in a lessened strain upon his credit.

(*a*) When applied to construction of buildings, the labor cost was reduced about one-half.

(Gilbreth: Record, p. 3424.)

(*b*) Even when applied in a business which, under the old method, had been most progressively managed for years, and thoroughly systematized, the introduction of scientific management produced the following remarkable results in different processes and operations, which are designated by letters.

	Saved in direct labor.	Saved in overhead charges. (Labor and general shop expenses.)
A	12 per cent	26 per cent
B	74	78
C	16	30
D	2	18
E	31	43
F	35	45
G	36	46
H	28	17
I	16	4
J	28	11
K	37	28
L	37	10 (increase)
M	34	24
N	63	81

(Towne, Record, pp. 3319–3320.)

(*c*) GANTT (Record, pp. 138–139).

"The fact that under this system everybody, high and low, is forced by his co-workers to do his duty (for some one else always suffers

when he fails) acts as a strong moral tonic to the community, and many whose ideas of truth and honesty are vague find habits of truth and honesty forced upon them. This is the case with those in high authority, as well as those in humble positions, and the man highest in authority finds that he also must conform to laws, if he wishes the proper co-operation of those under him."

(*d*) SCHEEL (Record, p. 3377).

"Mr. BRANDEIS. It appears, Mr. Scheel, that a very large amount of money must be spent in the aggregate by your company in paying these various men who, under different names of gang bosses and inspectors and investigators, are doing the instructing of the workmen, and others again who are keeping these extensive records of the daily performances. Has that money been expended profitably, so far as returns to the company are concerned?

Mr. SCHEEL. Yes."

14. *What the Consumer Gains from Scientific Management*

Experience in trade has shown that except where there is a close unregulated monopoly, the public always secures some part of the benefit gained by reduced cost of production. The reduced selling price comes, ordinarily, not as a voluntary concession, but because the demand of the consumer for lower prices proves irresistible in competitive or publicly regulated businesses, whenever the cost of production falls materially.

HATHAWAY (Record, pp. 3027–3028).

Thus in the Tabor Manufacturing Company selling prices fell ten to fifteen per cent in the last few years, while the general tendency of prices was upward.

The same was true of the Link Belt Company.

DODGE (Record, pp. 3137–3138).

"Mr. BRANDEIS. It does not pile up because the price of your article has been reduced?

Mr. DODGE. Yes.

Mr. BRANDEIS. By ten or fifteen or more per cent?

Commissioner LANE. Why have you decreased the price of your article?

Mr. DODGE. I think we have never solved this problem. As we are reducing costs, we have never been able to keep from giving that away to our buyers, because so many of our contracts are based on cost.

. . . . . .

Mr. BRANDEIS. Then, without or in spite of the effort that you might have made to retain the profit which has come to you, or which has come generally from the introduction of this scientific management, it has been divided between the workingman who has gotten an increase ranging from 25 to 35 per cent over the generally prevailing wage, as you understand it —

Mr. DODGE. As I understand it, yes.

Mr. BRANDEIS (*continuing*). And a part of it has come to the Link Belt Company?

Mr. DODGE. Yes, sir.

Mr. BRANDEIS. And a part of it has gone to the public, which has exacted a lower price?

Mr. DODGE. And did n't say thank you, either. (Laughter.)"

GANTT (Record, p. 3498).

"Mr. GANTT. I do believe that if the time comes when all industries get onto this basis, you will find a continual reduction in costs and under proper conditions a continual reduction in selling price, and consequently a continual reduction in the cost of living. Consequently, everybody would be benefited without an increase of wages."

15. *The Introduction of Scientific Management a Process*

The introduction of scientific management is of course a process, not a single act, and a process in which the element of time necessarily plays an important part.

1. Obstacles to be Overcome.

The men now employed must be taught the science; and what is even more difficult with most persons, must be taught to accommodate themselves to new ideas. While the difficulty in dealing with human nature is great, the chief obstacles to be overcome are not with the laborers and mechanics, nor indeed with the labor unions, but with those in authority. It is the foreman and assistant foreman, the superintendents and assistant superintendents, the managers and assistant managers, who present the greatest obstacles, men with pride of opinion, who feel, unwarrantably, that the introduction of a better system involves a criticism of themselves; subordinate officials who see their power diminished by the assumption of responsibility on the part of the management; and men with petty authority, who regard the appearance of the efficiency engineer as an intrusion upon their domain.

(*a*) Gantt (Work, Wages and Profits, pp. 130–132).

"Among the obstacles to the introduction of this system is the fact that it forces everybody to do his duty. Many a man in authority wants a system that will force everybody else to do his duty, but will allow him to do as he pleases. The "Task and Bonus" system when carried out properly is no respecter of persons, and the man who wishes to force the workman to do his task properly must see that the task is properly set and that proper means are available for doing it. It is not only the workman's privilege, but his duty, to report whatever interferes with his earning his bonus, and the loss of bonus soon educates him to perform this duty no matter how disagreeable it is at first. We investigate every loss of bonus, and place the blame where it belongs. Sometimes we find it belongs pretty high up, for the man who has neglected his duty under one system of management is pretty apt to neglect it at first under another. He must either learn to perform his duty or yield his place, for the pressure from those who lose by his neglect or incompetence is continuous and insistent. This becomes evident as soon as the task and bonus gets fairly started, and the effect is that opposition to its ex-

tension develops on the part of all who are not sure of making good under it, or whose expert knowledge is such that they fear it will all soon be standardized. The opposition of such people, however, is bound to give way sooner or later, for the really capable man and the true expert welcome these methods as soon as they understand them."

(*b*) GANTT (Record, p. 3469).

"Mr. GANTT. The principal obstacle is that it makes every man attend to his job. As a matter of fact, almost everybody wants to have the other fellow attend to his job and let him do as he pleases; but this system of management is such that the workman forces his foreman to do his job, the foreman forces his superintendent, and the superintendent forces the manager.

Commissioner PROUTY. You find the general obstacle is with the management, with the owner of the business?

Mr. GANTT. As a rule."

And yet, with the exercise of patience and tact, these difficulties, however great, can be and have been overcome.

GANTT (Work, Wages and Profits, p. 132).

"The fact that the task and the bonus enable us to utilize our knowledge and maintain our standards, and that the setting of tasks after a scientific investigation must necessarily not only increase our knowledge but standardize it, brings to our assistance the clearest thinkers and hardest workers in any organization. Our greatest help, however, comes from the workmen themselves. The most intelligent soon realize that we really mean to help them advance themselves, and the ambitious ones welcome the aid of our instructor to remove obstacles that have been in their way for perhaps years. As soon as one such man has earned his bonus for several days, there is usually another man ready to try the task, and unless there is a great lack of confidence on the part of the men in the management, the sentiment rapidly grows in favor of our task work."

2. FINDING BETTER METHODS.

Time is not only an important element in the mere introduction of scientific management, but much time must

necessarily elapse before the full benefit of scientific management can be attained. For progressiveness is of the very essence of scientific management; and the effort must be constantly made to seek with an open mind a better method of performing every operation. That involves intensified observation, research, and study into a territory largely unexplored.

3. GREAT GAINS IN SHORT TIME.

But although the largest benefits from scientific management cannot be secured for many years, very substantial gains can be secured in a short time.

(*a*) GILBRETH (Record, p. 3407).

"I tell you it will reduce your costs the first day you put it in. If you can spend the $25,000 Mr. Towne did, and have all of those refinements, as in a permanent mill under one cover, as Mr. Scheel testified, you are going to have still greater benefits; but who can afford in work outside, in contracting, as in my work — I can tell you about my work and not about any other — who can afford to spend $25,000 before he gets started? I do not know of anybody. We can give you those economies the first day if you take scientific management, and I urge you, gentlemen, to accept the invitation of Mr. Dodge of the Link Belt, and the invitation of Mr. Gantt and Mr. Scheel."

(*b*) EMERSON (Record, pp. 3559–3561).

"Mr. BRANDEIS. You have stated that these great economies were possible. In your opinion are large economies obtainable within a relatively short time?

Mr. EMERSON. There are certain economies which would take a very long time to accomplish. There are others, by far the largest, that it would take some time to accomplish, because it would depend upon the process of education. There are other economies in which results could be obtained in a comparatively short time. As I mentioned on the Santa Fé, the management they attained half the result between what they were doing and what I thought was an ideal performance, in two years' time.

Mr. BRANDEIS. Speaking generally, how do they go about the attaining of these economies?

Mr. EMERSON. We never paid any attention to attaining economy. The only thing we paid any attention to was the attaining of efficiency, feeling absolutely certain that economy would result as a by-product.

Mr. BRANDEIS. How would you go about attaining efficiency?

Mr. EMERSON. We brought with us, or ascertained from any sources that were available, by investigating, by past knowledge, by performing elsewhere, certain standards. We compared those standards with results actually being obtained. We then investigated all the conditions that resulted in this inefficiency of attainment, and we proceeded to eliminate the obstacles in the way.

For example: when I first went with the Santa Fé I knew that belting could be and can be maintained for 14 per cent of its first cost; that is, belting that is used in the shops. When we collected the records, we found that the cost of maintaining belting was 100 per cent of its first cost.

Mr. BRANDEIS. You mean the annual cost?

Mr. EMERSON. The annual cost. If you had fifteen thousand dollars worth of belting it was costing fifteen thousand dollars a yeat to maintain it, when it should cost in the neighborhood of about two thousand dollars.

Having that standard, and having the records showing the cost, we went to work to eliminate the causes of loss. We asked, in the first place, that they should give us the best belting made, without regard to cost. We wanted quality and not cost. We paid, in fact, five per cent above the market prices for the privilege of rejecting any belting that did not prove satisfactory. We next asked that the belting should all be put in the hands of one man, who should have exclusive charge of it, instead of allowing men that did not know much about it to repair their own belts on over-time. The third instruction given to the man was that he should have no belt failures; that is, that he should repair his belts before they broke down, and not afterwards, just as on a railroad you keep bridges maintained and do not wait for a train to go through the bridge before you build it up. As a result, we reduced belt failures by this method. The belt failures were reduced from 300 a month down to 50, and the cost dropped from 100 per cent down to the 14 per cent, which was the standard. Incidentally, we did not delay the machines,

and we had more output and better satisfaction from our belting. That same method was applied straight through every shop, to machinery and tools and locomotives, and right straight through the whole thing."

16. *Scientific Management and Labor Unions*

The claim has been made that scientific management and labor unions are inconsistent; that the organization of labor presents insuperable obstacles to the introduction of scientific management in railroads and other industries where unionism is potent. This claim, we believe, is wholly unfounded in fact.

(*a*) Collective bargaining is alike an important function under scientific management and under the old system.

GANTT (Record, pp. 3495–3496).

"Mr. BRANDEIS. But it is, as Commissioner Clark has pointed out, perfectly possible, and indeed very probable, that there would always be two sides to the bargain?

Mr. GANTT. Yes, sir.

Mr. BRANDEIS. Because you would have to fix the terms where the bonus would begin, and the amount of the bonus, and therefore collective bargaining in the sense of having a union to represent the workingmen, would not be so frequent perhaps in its application; but it would be just as necessary and just as beneficial in its operation as it is to-day, only under a system which, instead of producing friction and hostility, would produce the opposite; is not that so?

Mr. GANTT. I believe that is so.

Mr. BRANDEIS. And where, further, Mr. Gantt, operating under a system, the parties could come together with the knowledge of facts scientifically ascertained on which to reason out and base the conclusions that should come from that collective bargaining?

Mr. GANTT. I agree with you entirely. There is one thing which I have found throughout all my work: when the real facts were known, when each side stopped bluffing against the other, there was but little difficulty in coming to a proper agreement.

The reason why we do not have an agreement usually is because the two parties do not understand each other.

Commissioner CLARK. Other people have found the same thing."

(See Emerson: Record, pp. 3531–3532, quoted above, pp. 53, 54.)

(*b*) Unionism does not prevent the introduction of scientific management. It is true that unions, in some trades, have bitterly opposed the introduction of the piece rate or the bonus system *without scientific management*, just as other unions have opposed the day rate system *without scientific management*. And very intelligent labor leaders have from time to time objected — and objected properly — to ruthless methods of "speeding up"; but, as shown above, "speeding up" is not scientific management; nor, as also shown above, is the piece rate system, with or without a bonus, scientific management.

It will always require tact and patience to introduce radically new methods, whether the persons to be affected are organized or unorganized workers or are those "higher up." Tact and patience are essential to the introduction of scientific management in any business. But the experience of those who have been engaged in the introduction of scientific management in various businesses, in some of which closed, in others of which the open shop prevailed, clearly establishes that unions have not presented any obstacle to the introduction of scientific management, as soon as the nature and purpose of the changes proposed were understood and the good faith of the management was apparent.

(*a*) GILBRETH (Record, pp. 3401–3402).

"Your Honors, in answer to that first question of whether or not this scientific management can be applied to unionized shops or so-called closed shops, I wish to say that we have always made it a point to deal with unions by preference. In some localities where our work exists there are no unions, and in some cases there will

be union men and non-union men on the same job; but we have always made it a point to give preference to union men and union conditions.

We find that the men, as soon as they understand this, are very heartily in favor of it. There is no opposition whatever from any union man as soon as he knows what it is. Sometimes there is opposition from one of the foremen or an entire union during that period that they think there is a new game being sprung on them. They naturally are suspicious under the long period of wrong treatment that has come to them for generations, but they seldom act during that period. They never have acted on my work during that time, and by the time that they have finished considering what they will do they are converted and as a body are the best allies we have in installing scientific management."

(*b*) WILLIAMS (Record, pp. 3431–3433).

"Mr. BRANDEIS. You are the manager of the Manhattan Press of New York?

Mr. WILLIAMS. Yes.

Mr. BRANDEIS. And in that press you have introduced some of the principles of scientific management?

Mr. WILLIAMS. Some of them.

Mr. BRANDEIS. And you have introduced some of these principles in departments of your press, which is practically a closed shop?

Mr. WILLIAMS. One department, yes.

Mr. BRANDEIS. And that is the —

Mr. WILLIAMS (*interrupting*). The press room.

Mr. BRANDEIS. And the press men's union in New York is a very strong union?

Mr. WILLIAMS. Very strong.

Mr. BRANDEIS. In introducing these principles, you have introduced among others, the principles of the individual daily record of the men?

Mr. WILLIAMS. Yes.

Mr. BRANDEIS. And also the principles connected with it of paying the man a bonus who has reached the standard?

Mr. WILLIAMS. Yes.

Mr. BRANDEIS. Will you state whether or not, Mr. Williams, you have been confronted with any difficulties or obstacles on the part of the unions to the introduction of these principles of scientific management?

Mr. WILLIAMS. None but what, as soon as the men got confidence, would disappear. They do not believe it. They cannot understand that you are really wanting to pay them extra money; as soon as they can once get that through their minds, you have no trouble at all. We had to hold up the bonuses — I don't know just how long, but certainly three to five weeks — before they would take them. We kept putting them in the drawer, and finally some of them got brave enough to take them. We had a scheme of paying them which was one of my own ideas. We did not pay the bonus with the pay. We paid off on Friday, and we paid the bonus on the following Wednesday. One of the fellows said to me: "Those few extra dollars that we get on Wednesday come along about the time that we are hard-up, and they are better than the whole damn pay roll, that we have to take home. (Laughter.)"

(*c*) GANTT (Record, pp. 3461–3462).

"Mr. BRANDEIS. Mr. Kent testified to the introduction by you in the Canadian Pacific shops at Angus of some parts of the principles of scientific management. Do you happen to know, definitely, of the attitude of the union there, or the union officials, to the work?

Mr. GANTT. About a year after we began that work, Mr. Vaughan, who has charge of it all — he is assistant to the vice-president in charge of operating — said he had a very interesting session with a committee of the labor union; and he had told them that he had a piece work system that could not be cut. They felt very skeptical, but they listened to what he had to say and went away; and they have never made any comment since. They are apparently entirely satisfied. I have not heard that they have ever said anything about it since.

Mr. BRANDEIS. Mr. Gantt, is not this one of the things that happened: That they asked him what he was doing, and he said he was getting a very high-priced man to teach them to do the work easier?

Mr. GANTT. Something like that; something in that line; that he was getting the best man he could to teach those people to do the work easier. That is what we are working at. We are trying to find the easiest, and the easiest is usually the best, way of doing the work, and then teaching those who would not normally learn that method, — teaching them and helping them to apply it."

(*d*) KENT (Record, pp. 3442–3443).

"Mr. BRANDEIS. Will you state what you found to be the attitude of the officials in charge of the work there toward the system, so far as the introduction of it was concerned?

Mr. KENT. One of the foremen said that if they went back to the old method of doing things, he would quit his job; that he would not stay there.

Mr. BRANDEIS. What did the superintendent say?

Mr. KENT. Why, he was most enthusiastic. His labors were considerably lightened, it seemed, and he was able to give more attention to the actual planning of the work of the shop.

Mr. BRANDEIS. Do you know whether that shop is an open shop or a closed shop?

Mr. KENT. It is a union shop."

(*e*) HATHAWAY (Record, pp. 3064–3067).

"Mr. BRANDEIS. What is the attitude of the men in your shop towards this work?

Mr. HATHAWAY. The men who work in our shop under this scheme seem to be perfectly satisfied and contented with it. We have had some men who have left our employ for a time and worked under the old conditions, who were always very desirous of coming back to us. After they once work under this scheme and understand it, they seem to prefer it to the old scheme.

Mr. BRANDEIS. Has there been at any time any complaint or is there any complaint in your shop that the men are being speeded up or made to work harder?

Mr. HATHAWAY. No, none that I have heard.

Mr. BRANDEIS. Your shop is situated in what might be called the machinery manufacturing district, is it not?

Mr. HATHAWAY. Yes.

Mr. BRANDEIS. You are surrounded by quite a number of manufacturers?

Mr. HATHAWAY. Yes, there are a great many.

Mr. BRANDEIS. How many machinery manufacturers?

Mr. HATHAWAY. There are five or six large representative concerns, among them the Baldwin Locomotive Works, which, of course, is of itself much greater than all the rest of them together.

Mr. BRANDEIS. The Midvale Steel Company?

Mr. HATHAWAY. That is some distance from us, but in the same

city. Right in our immediate neighborhood there is William Sellers & Company, Harrington & Sons, the Newton Machine Tool Works, and there are a few smaller concerns, but those are the principal ones.

Mr. BRANDEIS. At the time last spring of the general strike in Philadelphia, what was the attitude of the men in your shop as compared to what it was in the surrounding shops?

Mr. HATHAWAY. We had one man who joined in the sympathetic strike or general strike, whereas Baldwin's had some 2,000 or more, I believe; William Sellers had about from one-half to two-thirds of their force; Newton Machine Tool Works had practically all of their men out; Harrington had most of their men out. We had one man out.

Mr. BRANDEIS. Did you yourself make any effort to retain the men?

Mr. HATHAWAY. No.

Mr. BRANDEIS. At that time?

Mr. HATHAWAY. No.

Mr. BRANDEIS. Is it absolutely true that the action of the men in remaining, all except that one out of seventy-five, was entirely of their own motion?

Mr. HATHAWAY. Yes.

Commissioner PROUTY. Is your shop a union shop?

Mr. HATHAWAY. Our shop is an open shop; we have some union men and some non-union men.

Mr. BRANDEIS. How is it with regard to these other shops you have spoken of?

Mr. HATHAWAY. They are all in the same fix.

Mr. BRANDEIS. They are all open shops?

Mr. HATHAWAY. Yes.

Mr. TRANDEIS. They are none of them closed shops?

Mr. HATHAWAY. I think in Philadelphia there are practically no closed machine shops. I do not know of any.

(*f*) KENDALL (Record, pp. 3436–3437).

"Mr. BRANDEIS. In the Plimpton Press, which is a printing and binding establishment, complete, you have certain departments in which there are a number of union men?

Mr. KENDALL. We have.

Mr. BRANDEIS. And have you, in those departments, met any obstacles on the part of the unions to the introduction of those features of scientific management which have been applied?

Mr. KENDALL. We have met with no obstacles whatever; but the same attitude which applies to non-union employees has also applied to the union employees. The average American workman, in fact the average workman of any country, appreciates lack of trouble. Scientific management does away with his trouble. The bonus feature is an additional help, and the union and the non-union men are welcoming these features which do away with their trouble, and are also welcoming the bonus features."

(*g*) EMERSON (Record, pp. 3558–3562).

"Mr. BRANDEIS. In your effort to improve the efficiency of various concerns, has the question come up for consideration as to any difficulties or obstacles presented by the workmen themselves and particularly by the labor unions?

Mr. EMERSON. Occasionally that question has come up. On the whole, that has not been our difficulty.

Mr. BRANDEIS. What difficulty has there been?

Mr. EMERSON. The difficulty has been generally in persuading the management to take the necessary steps to bring about the results. When I say "management" I mean somebody above the ordinary workman. It might be the foreman or the superintendent, or it might be the general manager. It might be anyone that is in the line above the workman."

17. *Scientific Management Applicable to all Businesses*

Experience has already demonstrated that the principles of scientific management are general in their application, and can be introduced into practically all businesses, and all departments of any business. They have been successfully applied in private competitive businesses, like machine shops and factories, steel works, and paper mills, cotton mills and shoe shops, in bleacheries and dye works, in printing and book-binding, in lithographing establishments; in the manufacture of typewriters and optical instruments, in construction and engineering work, and in establishments not commonly regarded as business, and

recently to some extent they have been introduced by the United States Government into the manufacturing departments of the Army and Navy.

The application of these principles has been no less successful in the field than in the shop. They have been found applicable alike to the most skilled and to the most unskilled labor, to conditions where men work in large numbers together in a single factory, and where they are more widely scattered.

They have been applied in businesses of great complexity, in which the articles manufactured differed widely, as well as in businesses where the work is largely repetitive, and this result would seem to follow necessarily when one considers what scientific management is — that is, what the main principles are which compose it: namely, preparedness; separation of planning from performance; the analytical study of every operation, with a view to determining the best possible methods, tools and machinery; the management thus performing its proper function, — of enabling the work to be done under best possible conditions; and the keeping of a current record of the efficiency of men, equipment, and materials.

The evidence produced as to the value and general applicability of the principles of scientific management was deemed by the Commission to have been so conclusive, that upon the suggestion of the acting Chairman we refrained from calling additional witnesses to this point.

"Commissioner PROUTY. Mr. Brandeis, you can hardly add anything to your case by calling the representatives of some other industry and showing these same principles have been applied there. It is perfectly evident that if they have been applied in one case they can be applied in another analogous case. If the railroads were to show, in answer, some facts which tended to prove that they could

not be applied to railroad operations, then you might desire to go further; but it seems to me you have made out your case now as far as it can be made out. If you have anybody who can show this method has been applied to railroad operation, he would be a material witness." (Pp. 1387–3388.)

"Commissioner CLEMENTS. . . . Of course this thing could be carried on and on almost indefinitely with respect to different lines of business.

Mr. BRANDEIS. It could, indeed.

Commissioner CLEMENTS. And when you have shown that fact, and what you have done with respect to several kinds of business, and the details of it, so far as it may be helpful to any extent, does not that illustrate the possibilities in all lines of business just as well as if you were to call them in other cases?

Mr. BRANDEIS. It does to my mind absolutely, but I did not know that others, who had given less consideration to the subject, might be so ready to accept the conclusion which we ourselves have formed. I will endeavor to act upon the suggestion of the Commission."

(Mr. Clements was then sitting as Chairman during Commissioner Knapp's absence.) (Record, pp. 3389–3390.)

18. *Scientific Management is Applicable to Railroads*

No good reason can, it is believed, be alleged why scientific management is not applicable to most departments of railroads.

(*a*) TOWNE (Record, pp. 3292–3300).

"Mr. BRANDEIS. Have you considered, Mr. Towne, at all, the question of the possibility of economies in connection with railroad operation?

Mr. TOWNE. I have often given it casual thought, in connection with my general interest in this great subject; and since this investigation commenced, and my attention as President of the Merchants' Association of New York was directed to the shippers' side of the case very strongly, I have given a great deal of thought to the effort to see how my experience in industrial management

and manufacturing might indicate to me the possibilities of similar results in the field of railroad management.

Although I confess to no experience in that field, I have had the same opportunity that any citizen has to come in contact with it, as a business man and otherwise. In addition to that I have a pretty large acquaintance among railroad men and have frequently discussed with them the problems that they are working out in this direction, so that I have some general knowledge; but none that I pretend to class as expert knowledge.

Mr. BRANDEIS. However, have you any opinions or suggestions on the subject which you think would be of value to the Commission or might possibly be?

Mr. TOWNE. Why, it seems to me that there are almost as great possibilities for self-help on the part of the railroads as there are and have been proved to be on the part of manufacturing industries.

They have a great many problems that are similar, and some that are identical. Take the case of their machine shops and repair shops, which are quite a large element in their organization and in their total outlay. They have precisely the same conditions as exist in any machine shop or car-building shop which is devoted to a similar work of a general kind.

I have no doubt whatever that the systems which are being so successfully developed now, in many private establishments, for increasing the efficiency of machines and of men, in machine shops and foundries and wood-working establishments, can be utilized and availed of in the corresponding shops of the railroad companies, especially the large ones.

Commissioner LANE. Do you know that they are not?

Mr. TOWNE. I imagine that they are being availed of in some places and to some extent. I should doubt, exceedingly, that they are availed of widely, or else, from my general reading in engineering matters, I would have known something about it; and I doubt whether, in any case, they are availed of as fully and effectively as they are in some private establishments. For one reason, the incentive is wanting. The railroads are not operating, in this respect, at least, under the competitive conditions which private industries are, and they lack the stimulus which the private establishment has, and sometimes has acutely, as my own did in the years after 1893 — the stimulus to take up and study and solve problems of this kind. The men who are responsible for the management of

these particular railroads that I have been speaking of have little or no pecuniary interest in it, and their superior officers have none except of the general character of their responsibility to their next higher officials and to the stockholders. But there is not the same sense of acute personal, direct responsibility that there is in a private corporation, and especially in a corporation where the chief owners are the chief managers.

The experience that has been gained under conditions of that kind, which are the most favorable conditions, is open to the railroads for study and for approbation and utilization, if they see fit to seek it and avail of it.

But I see other directions in which, it seems to me, the railroads are far behind the times in these matters, and in several directions. One of them is in the effort to utilize modern mechanical skill and ingenuity and experience in every productive industry that I am familiar with, and I know something about quite a number of them. Inventive ability and experience have developed wonderful changes in the last twenty-five years, in the last ten years, in the substitution of better machines, machines that are largely automatic in many cases, and in the more intelligent application of human labor, even to machines which are unavoidably not automatic.

In every mechanical industry there is a constant effort to study this problem, and to achieve further success in it. In fact, I think most people who have been in touch with it feel that, with all the wonderful things that have been accomplished, we have only made a beginning, and that greater results are surely before us in the future.

On the part of the railroads, I fail to see any corresponding effort. I do not see that the railroads have awakened to the existence of these conditions, so far as their employment of manual labor in the performance of the work of the railroads is concerned. And manual labor constitutes a very large part of the expenditures of every railway, in the handling of freight, of baggage, of the manipulation of traffic, and so on — it is all manual labor. And as to the cruder parts of it, the railroad companies to-day are employing the same means of utilizing manual labor as the Egyptians did, or would have done if they had had railroads in those days.

Commissioner LANE. Will you be a little bit more concrete on that proposition?

Mr. TOWNE. I will. To take a somewhat minor example: All of

us citizens who have to travel on the railways are unpleasantly familiar with the crudity of the systems employed at present, or lack of system, in handling passengers' baggage. We know how our baggage is maltreated and damaged, and any one who will think of it for a minute will see that there has not been the faintest effort to apply modern mechanical appliances to the handling of baggage, except in a few of the great terminals where they do use an elevator to hoist it from one level to another. The witness who preceded me, Mr. Dodge, has made it the business of his life to design conveying machinery, and there are four or five other large establishments and many smaller ones in this country who make that their sole business, designing and building machinery for the conveying of materials of all kinds. It is a surprise to me that they have not taken up this problem, on their own initiative; but I am quite sure that any or all of them would be glad to take it up on the initiative of the railroad companies, and endeavor to find methods for handling baggage mechanically, at least in the larger terminals, if not in the smaller stations.

Whatever may oe possible in the way of handling baggage mechanically, a vastly greater field exists in the possibilities of handling freight mechanically. It is done already, by some of the great coal carriers, and to some extent, in the handling of coal, and in a few cases that I have seen, in the handling of sand, materials that will flow, like sand and coal. But no effort has been made that I know of, to apply mechanical methods to the handling of the vast volume of merchandise which the railroads handle at every terminal, onto their platforms, from the platforms to their cars, back again from the cars to the platform, and from the platform to the truck, or whatever else it is carried away in. Millions of tons of material, taking the country as a whole, are moved every day, and moved by the crudest kind of labor. I am absolutely sure, as to some cases — I believe in a great many cases — probably in all of the great terminals, that mechanical appliances could be successfully availed of, at least for some part of that work; probably for a great part. But, so far as the public knows, no effort has been made in that direction whatever.

I see another field, drawing an inference from my own experience as a manufacturer, in which I believe that the railroad companies have not gone far, and some have not ventured at all; and that is in what has come to be known, under the nomenclature of this modern

scientific industrial system, as functional management. I can illustrate or explain that in a few words, best by reference to a factory or workshop of the average kind and size.

Under old conditions, what was sometimes referred to as the military system prevailed, in which the foreman or superintendent of each department or room was responsible for everything done in that room, — the discipline, the adjustment of wages, the allotment of work, the instructions to the workmen as to what they were to do and how they were to do it, the inspection of the product of the workmen, and, in fact, everything pertaining to the management of the work in that room was concentrated in the hands of one person, possibly having some assistants.

Under the functional system, on the contrary, the management of one room will be covered by four, five, six, and in some cases even ten different persons, the responsibility of each of whom runs on functional lines. One man will have to do with the employment of help. Another with the adjustment of wages and piece rates; another with the allotment of work, its distribution to the different men and machines; and another with the ascertainment of labor costs, and so on. The functional system, where it has been availed of intelligently, is proving itself over and over again to be the sounder system of the two. It is in line with the specialization in all of the sciences, in medicine, in law, and so on, that a man who devoted his whole time to one single line of study or research or work becomes more skillful and expert in that than if he attempts to diffuse his labors over a multitude of operations. That higher or intensified skill results in the ascertainment of better methods, much to the operation in the plant where the functional system is in use.

We can see that if the railroads are not already fully availing themselves of the functional system, there must be a very great opportunity for them to do so. They could do that in their office work, in their great central administrative offices, which each one of the large systems has to maintain, and in the subordinate offices, which many or most of them maintain at other points, and throughout the operative system, wherever a large number of men are gathered together under one control and for a combined result."

(*b*) EMERSON (Efficiency, p. 80).

"Railroad practice has many standards, chiefly those of specification, of construction, and of times for passenger trains. No railroad

has ever determined any cost standards either for maintenance or operation of equipment, maintenance of way, or consumption of fuel, yet there is no railroad in the country on which each one of these cost standards could not be determined in a very short time and with very close accuracy, at a cost equal to the saving effected in a single month."

(1) Maintenance of equipment, consuming about 20 per cent of all operating expenses, involves conditions in machine shops, locomotive and car shops and yards, similar in large measure to those under which scientific management has been most successfully applied in private businesses.

The fact that the Atchison, Topeka and Santa Fé Railroad and the Canadian Pacific Railroad Company have, to some extent, introduced principles of scientific management in their machine shop and locomotive shops with good results, is an illustration of this.

(*a*) EMERSON (Efficiency, p. 80).

"When each unit of locomotive repair is standardized, the sum of the units shows a cost between $0.03 and $0.06 a mile for maintenance. The actual average costs on the railroads are between $0.06 and $0.12 — therefore twice what they ought to be. The standardized cost of maintaining freight cars is as low as $30 per annum. Actual average costs run from $45 on some roads to over $100 on others."

(*b*) EMERSON (Record, pp. 3540–3542).

" Commissioner PROUTY. Proceed, Mr. Brandeis.

Mr. BRANDEIS. If you desire, I can read from this book, "Methods of the Santa Fe," the figures for the different years, which may perhaps answer some of the questions which you have asked the witness in regard to the effect during a period of years.

This is on page 37 of Mr. Going's book.

Repairs and renewals to shop machinery and tools. 1902 to 1903: Total charges, $401,809; cost per locomotive, $306.96; cost per tractive unit, $9.0136.

1903 to 1904: Total charges, $487,170; cost per locomotive, $339.96; cost per tractive unit, $.0132. 1904 to 1905: Total charges, $486,620; cost per locomotive, $334.68; cost per tractive unit, $.0127.

1905 to 1906: Total charges, $367,474; cost per locomotive, $225.03; cost per tractive unit, $.0081.

1906 to 1907: Total charges, $315,844; cost per locomotive, $176.35; cost per tractive unit, $.0060.

1907 to 1908: Total charges, $290,809; cost per locomotive, $157.11; cost per tractive unit, $.0053.

In other words, between 1903–4 and 1907–8 the repairs and renewals to shop machinery and tools dropped from $487,170 to $290,809; the cost per locomotive from $339.96 to $157.11; and the cost per tractive unit from $.0132 to $.0053.

Mr. Going says at page 58 in his book:

"The table below shows the economy in the labor account for engine repairs over a five years' period."

He then goes on to detail that in the fiscal year 1902–3 the labor cost was $2,362,000; the number of locomotives owned was 1309, and the cost per engine was $1,804.

In the fiscal year 1903–4 the labor cost was $3,000,122, the number of locomotives owned 1433, and the cost per engine $2,094.

In the fiscal year 1904–5 the labor cost was $3,336,963, and the number of locomotives owned was 1454, and the cost per engine was $2,309.

For the fiscal year 1905–6 the labor cost was $2,739,195, the number of locomotives owned was 1633, and the cost per engine was $1,677.

In 1906–7 the labor cost was $2,800,250, the number of locomotives owned 1791, and the cost per engine was $1,564.

In 1907–8 the labor cost was $2,763,825, the number of locomotives owned was 1851, and the cost per engine was $1493.

In other words, the cost per engine drops from $2,309 in 1904–5 to $1,493 in 1907–8.

Commissioner PROUTY. That is the labor cost?

Mr. BRANDEIS. That is the labor cost, yes, sir."

(*c*) EMERSON (Record, pp. 20–22).

"Railroad repair shops throughout the country do not show 50 per cent efficiency on an average as regards either materials or labor, A case observed was as follows:

A foundry made, for a railroad shop, big cylinder bushings. These,

after being machined in the railroad shop, weighed about 375 pounds, but the original casting weighed 1,780 pounds. It took three days to remove 1,405 pounds of cast iron. It should have taken less than one day if the rough bushing had weighed only 600 pounds. The difference in result is reduced to financial expression in the following table:

COMPARISON OF COSTS

	As made	Standard
Weight, rough	1,780	600
Cost per pound	$0.04	$0.04
Total cost	$71.20	$24.00
Labor	3 days	1 day
Cost of labor, $3.00 per day	$9.00	$3.00
Machine charge, $2.00 per day	$6.00	$2.00
Overhead charges, $2,00 per day	$6.00	$2.00
Total cost	$92.20	$31.00

In this same shop the most efficient men were checked up and found to average only 60 per cent in actual output, compared to realizable standards. At the end of two years of persistent effort many of the best men were brought up to 110 per cent efficiency, but there were still men as low as 10 per cent as to actual output compared to reasonable standard — the same standard on which others realized 110 per cent.

In another big locomotive shop, a careful study of the machines which had been in operation for 20 years showed that the location of 75 per cent of them would have to be changed, so as to facilitate the orderly, effective, and economical progress of work from one to the other. This and other eliminations of wastes doubled the output, with less labor costs.

In consequence of general shop inefficiency and operation inefficiency due to similar causes, locomotive repair costs, on Western railroads, run from $0.08 to $0.12 a mile; yet a most efficient superintendent of motive power on a large transcontinental road succeeded in dropping to $0.05 and had only touched the high spots, his well-considered opinion being that $0.04 was reasonably attainable. On another transcontinental road, repair costs per mile were dropped from $0.1374 to $0.08 by persistent effort, but when the efforts were relaxed expenses immediately rose to $0.17. They should have come

down to $0.06. Eastern and Southern roads, with their small engines, better coals, and better waters, are not to imagine that they show any higher efficiency. They are on the whole worse.

A leading eastern road established piece rates in its car shops and then limited the earning power of the men. When there was a sudden demand for increased car repairs, the limit was taken off and the men doubled their earnings. Then the limit was put back. The large Eastern roads have signally failed in attempts to increase the efficiency of their repair shops.

In a leading Southern shop many men were receiving 12-hours pay for 3-hours work."

(*d*) KENT (Record, p. 3442).

"Mr. BRANDEIS. Will you state what you found to be the attitude of the officials in charge of the work there toward the system, so far as the introduction of it was concerned?

Mr. KENT. One of the foremen said that if they went back to the old method of doing things, he would quit his job; that he would not stay there.

Mr. BRANDEIS. What did the superintendent say?

Mr. KENT. Why, he was most enthusiastic. His labors were considerably lightened, it seemed, and he was able to give more attention to the actual planning of the work of the shop."

(2) Maintenance of way consuming nearly 20 per cent of the total operating expenses of railroads, involves conditions in many respects similar to work done by contractors, and to field work done in connection with other private businesses.

(*a*) EMERSON (Efficiency, pp. 80–81).

Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30 per cent.

(*b*) TOWNE (Record, pp. 3202–3303).

"I think there was one other point, Mr. Brandeis, if you will allow me to add to this somewhat long answer to your innocent question: The previous witness has explained, I believe, what is known as

time-study, which is a very modern, recent invention. There were spasmodic attempts to understand and utilize it a good many years ago, but it was not intelligently understood and utilized until within the last few years. It has been shown by Mr. F. W. Taylor and Mr. Gilbreth and others that the use of the time-study system, which is the application of brains to manual operations, will produce results, not merely in the operation of intricate machinery, but equally in the performance of the simplest operations, such as the handling of pig iron, the handling of coal, the laying of bricks, and so on.

The railroads are immense employers of unskilled labor. They use it in their construction work, in the maintenance of tracks, the laying of ties and of ballast and of rails, and in all of the repair work in their terminals and stations and of their stock; and, as far as I know, with a few exceptions, the exceptions being chiefly in the repair shops of the railroads, no effort has been made, or no test or experiment has as yet been made, to ascertain the extent to which time-study may be utilized in railroad work, to intensify production, with the result, as it is proved in industrial operations, of simultaneously reducing cost and increasing the wages of the workmen."

(*c*) GILBRETH (Record, pp. 3416–3417).

"Mr. BRANDEIS. From your own experience in your particular business of contracting and building and construction, what part of railroad operations or constructions could you speak of with perhaps the authority of experience as to its applicability there?

Mr. GILBRETH. Any hand labor, shoveling, picking, lifting, or carrying of heavy weights in their thousands of applications, whether it is the loading of freight or unloading of freight or any of those things. We have seen the art of shoveling, which we used to consider consisted of handing a man a shovel and seeing that he worked. We have seen that they have now established certain standards before we pass the shovel to the man, and by so doing we can get him to do three times as much work. I have seen cases, I know of cases that I have seen with my own eyes where it was nine times as much work with very little more effort on the part of the workman."

(3) Transportation consuming about 50 per cent of the total operating expenses of railroads, involves operations in which it is clear that scientific management would produce large results. For instance:

(*a*) The cost of fuel is on all railroads a large per cent of the total transportation expenses. It has been demonstrated that, by proper instruction, fuel consumption could be reduced at least one-half.

EMERSON (Efficiency, p. 81).

Staff determinations with a dynamo car showed that 1,000,000 B. t. u. in the coal were amply sufficient to furnish power to move a 1,000-ton train one mile. The actual coal charged to locomotives always contained more than twice as many, often three times as many, B. t. u.

EMERSON (Record, pp. 3551–3553).

Mr. BRANDEIS. You spoke, Mr. Emerson, of the fuel bill being a particularly heavy bill, and I understand as affording a special opportunity for economy. Have you made any particular study or observation on that subject?

Mr. EMERSON. Yes.

Mr. BRANDEIS. What?

Mr. EMERSON. On the Santa Fé we set up a system of records, or we had them set up for us, so we could utilize them, showing how many pounds of fuel they used per thousand train ton miles, freight train ton miles, and the average for the whole road was at that time 261 pounds. We started in then, by various suggestions and hints that were given to various officials, to see if we could not bring that fuel consumption down, and it did slowly come down. I think it ultimately reached 239 pounds.

We sent a young man up to the Chicago, Milwaukee & St. Paul to investigate their fuel records, which were among the best in the United States as to practices in the use of fuel at that time, and we found they averaged in the neighborhood of 175 pounds of fuel consumed. So we came back, and more or less set up as a provisional standard the 175 pounds.

About that time the superintendent of motive power wrote to me that a dynamometer car running on the road showed a record of 80 pounds. I ridiculed the record. I was skeptical. I would have to be shown. I checked up the fuel records and knew that 80 pounds was not a likely figure at all. That letter of mine was sent to this man that was running the dynamometer car and he wired back: "Mr. Emerson is the party we have been looking for. If there is anything

the matter with our record, we want to know how to improve them. Please send him here at once, or one of his representatives, to check us up." That called me very nicely, so I put one of my assistants, the same man that had been making locomotive studies, on the run out of Chicago, and told him to find out by actual weight just exactly how many tons of coal were necessary to move a thousand tons a mile. His report came back 78 pounds. I said, "Try it over again." I think the next time it was 81 pounds. He made three tests of that kind. By that time I was convinced that the dynamometer car man knew what he was talking about. I then went in person and spent some time with that car, and I found that it was actually consuming, on the most careful tests possible, in the neighborhood of 80 pounds, as against the average that was checked up of from 260 pounds down to 240 pounds.

(*b*) The terminal expense, particularly the loading and unloading of cars containing shipments in the less than car load lots, presents perhaps the most burdensome of all expenses of railroading. Nearly everywhere on American railroads the methods of loading and unloading pursued are substantially the same as those used in the days of the Pharaohs.

(See Towne, above, p. 75.)

(*c*) The purchase, care and use of materials and the utilization of plant present also wide fields for the application of scientific management.

(*d*) The avoidance of the terrible delays and irregularities in freight transportation offer a large field for increasing efficiency with incidental economy.

19. *How Railroads can Co-operate to Reduce Costs*

Railroad operation presents an especially favorable opportunity for co-operation through the introduction of scientific management.

The fact that the railroad business is subject in its accounting to the orders of this Commission, makes it possible for the Commission to require that each company ascertain and report to it the simple ultimate unit costs of each operation in every department of the road. The further fact that the railroad business is largely non-competitive makes it proper to publish these costs, and to give to each railroad the benefit of knowing the lowest elementary unit cost of each operation attained by any railroad, and how it was attained. The ascertainment of the ultimate unit cost is necessary before an instructive basis of comparison can be had. The knowledge that the average annual cost per locomotives of repairs, renewals and depreciation on one railroad is $3832.37, and on another is $2709.27, would be a very unsafe guide for determining the relative economy of operation on the two railroads. The conditions on the two railroads, and standards of renewal and depreciation may vary so that the company expending the greatest sum may actually have conducted its locomotive use and repair more economically than the railroad expending less. What is needed as a basis for comparison are the ultimate unit costs; the cost of turning a wheel, the cost of laying a tie or rail under particular conditions, and even that relatively simple operation must again be analyzed and separated into its ultimate simple elements.

The attainment by each railroad, for each operation, of the lowest cost attained by any railroad for that operation, would not, however, satisfy the demands of scientific management. To attain only the best that has been done presents rather the beginning than the end of economies which scientific management contemplates. With the ascertainment of the lowest existing costs the study must be made whether there are still waste time and effort involved in

the best existing method of performing that particular operation, and of eliminating such waste when determined. And when that shall have been done, there will still remain the wide field of research for a better way of doing the same thing.

The railroads have combined to maintain rates. There can be no proper objection to their co-operating in reducing costs — co-operating with a view to dividing among themselves the great task set by scientific management; the task of investigating how in each operation in each particular department greater efficiency can be attained, and how costs can be reduced; and then imparting each to each of the others the results of such investigations.

(*a*) TOWNE (Record, pp. 3000–3002).

"I see an opportunity for the railroads, also, to avail themselves of another thing, in which they have the advantage over private establishments, and that is by the adoption and utilization of a well-planned scheme of comparative statistics. If all of the railroads were keeping their accounts upon a common system, at least as to the more important of their operations, and if those accounts were made interchangeable, each railroad would have the advantage of learning, from month to month, what all the other railroads were doing, and of seeing how near the head or how near the feet of the procession his own system was. There would be a rivalry, a stimulus to each one of them, to know the direction in which their management was less efficient and economical than in the average or the best; and to try to catch up with these who were ahead, and to learn how they had reached these better results, and to attain the same end.

The railroads can afford to exchange information of that kind, because they are not directly competitive; whereas the private establishments exist under conditions of such intense competition that none of them can afford to open its books and records to its neighbor or its competitor and show how its economies have been attained, and therefore put the competitor into position to utilize those without any reciprocal compensation. As a matter of fact, no such interchange of information exists in competitive business.

The railroads could have that. I believe that, by availing of a system of comparative statistics and interchanging that information,

the railroads would derive incalculable assistance in studying the effects of that system, where they exist, and in improving their methods of management throughout.

(*b*) EMERSON (Record, pp. 3564–3565).

Mr. BRANDEIS. Is there any way you have to suggest to the Commission as to how the railroads collectively, or the railroads indirectly, through the Commission, could contribute largely to the reduction of cost of operation?

Mr. EMERSON. I think we have a splendid example of the kind of work that ought to be done in the Department of Agriculture of the United States. If an attempt should be made by every farmer to put on his own staff of specialists as to the growth of crops, he would find it very difficult, he could not do it; he could not find the specialists; he would find the burden very heavy. The Department of Agriculture collects the experiences of men all over the United States, and, for that matter, all over the world, and places those experiences at the disposition of those farmers who want to make use of them. Not only that, but they send out men to instruct communities and to instruct districts, to show them how it can be done. They pick up certain farmers who become models for their own community, and other farmers can imitate them.

The trouble in studying the records of the railroads as presented to the Commission is that they do not rest on what we call fundamental units. The figures at the top are accurate, but when you go further down you get into a fog, and you find you are in absolute uncertainty. It is one of the most difficult things in the world, for instance, to find out what mileage a locomotive has made. In the earlier reports the train mileage, I believe, is reported. It is not the locomotive mileage. On certain roads they count the train mileage as locomotive mileage, or sometimes the accredited amount of one hundred miles a day. Some railroads do not keep the records. So that what is needed is that there should be reliable records and a reliable exchange of information and opinion and instruction as to these fundamental units that go to build up the cost of the operation of a railroad.

Mr. BRANDEIS. And there should be, should there not, Mr. Emerson, a publication of those records under the control and direction of the Interstate Commerce Commission, so that the public, through its authorized representatives, might aid and assure them-

selves of the correctness and the use of that information, with a view to the reduction of cost, an operation in which the public is so largely interested?

Mr. EMERSON. I believe that is largely the practice of the Agricultural Department, except there it is voluntary, I believe.

20. *Eliminating Graft as a By-Product*

There is a persistent belief current that graft prevails to a large extent in the administration of many of our railroads. The recently discovered gross frauds on the Illinois Central (one of the railroads supposed to be well managed) is only an example. The investigation made by this Commission in 1906 into the "Discrimination and Monopoly in Coal and Oil," reported to the House of Representatives under date of January 25, 1907, disclosed such graft among officials of the Pennsylvania Railroad Company (page 26) under the administration of its great President, Mr. Cassatt, and likewise on the Baltimore and Ohio Railroad Company (page 28).

The frequent publication of unit costs of all of the railroads would be a great deterrent to graft. It would afford a practical means for disclosing, particularly in connection with the purchase of supplies and in construction work, the existence of excessive costs which are nearly always an incident of graft. A like publication of specifications and costs of work done under contract would conduce to the same end. The huge size of most of our railroad organizations makes such complete and intelligent publicity an essential condition of freedom from graft.

Scientific management, including a skillful application of the bonus system, would aid in the elimination of graft in ways other than publicity. By giving to various classes of employees a financial interest in securing particular

low costs as was done by the Brighton Mills, the graft of any employee would injure his fellows as well as the company; and the self-interest of the other employees would afford the railroad the best protection.

SCHEEL (Record, p. 3373).

"Mr. BRANDEIS. What had been the attitude of the men in one department toward any lack of efficiency in the other departments?

Mr. SCHEEL. The critical spirit in one department against the performance in a preceding department has grown quite gradual where it affects the performance in the succeeding department. In other words, if the weave shed is going to suffer because of the poor performance of the filling winders, friendship does not any longer stand in the way of the management hearing of such incorrect work on the part of the filling department.

Mr. BRANDEIS. Then is it or not a matter of more or less frequent occurrence that the men themselves will come to the management and call attention to obstacles or defects which prevent the free and uninterrupted flow of work through the mills?

Mr. SCHEEL. I think so, yes, much more so than before."

21. *Railroads are not Scientifically Managed*

It is, no doubt, true that some of the railroads are competently managed, so far as that can be done under the old methods. Other railroads, while not managed competently as a whole, are no doubt managed competently as to particular departments, divisions, or operations. But so far as appears in evidence, scientific management has not been introduced into any department of any railroad operating within official classification territory. None of those persons who have been most carefully following the subject of scientific management have ever heard of any such introduction.

(Towne: Record, p. 3294.)
(Kent: Record, p. 3449.)

No railroad operating within official classification territory has even made the claim that it had introduced the principles of scientific management. And we submit that in view of the following notice given by us at the close of our evidence on the subject of scientific management, it would not be open to any railroad to claim now that it had introduced scientific management.

"Mr. BRANDEIS. May it please your Honors, as we understand the situation, in view of the evidence that we have introduced, we suppose the burden of proof to remain upon the railroads, if this question of their need is at all to be considered, to show that they have attained, by means of scientific management, the possibility in economies in operation which we believe do not exist.

So far as we are advised, there is not, within official classification territory, any railroad which has adopted methods of scientific management in matters relating to maintenance of way, or maintenance of equipment, or to the handling of freight, transportation or terminal.

Perhaps I ought to say that certain information was given me in confidence to the effect that upon one railroad, in one small part of that railroad, in one department of it, certain principles of scientific management have been introduced, with the same excellent effects in the way of economy which our witnesses have testified to. As that information was given in confidence, and as it has only come to me very indirectly, I have not thought it proper to call it otherwise to the attention of the Commission.

But if the claim is made on behalf of any railroad in official classification territory that it has instituted principles of scientific management, obtaining, therefore, the economies possible to which we have called attention, then I ask, in the first place, the privilege of examining, in a proper manner before an examiner (because I suppose this Commission would not have the time to permit me to do it) — I ask the privilege of examining before an examiner of this Commission the operating man or men of that railroad that makes such a claim. And I ask, in the second place, for the privilege of having our experts go into the shops, if shops they be, or otherwise to go where the work is done, and have access to the records of such railroads, with the view to determine whether or not, upon such inspection and assay as an expert only is competent to make, that claim has any

foundation in fact; in order that we may, not only through an examination of the operating men themselves, but also through that expert examination to be made by our experts who have examined the premises, the methods and the accounts, report to this Commission what the facts are."

22. *Scientific Management does not Involve Large Capital Expenditures*

The economies introduced by railroads within the last fifteen years — straightening curves, reducing grades, strengthening road beds and bridges so as to permit the use of large cars and engines, and purchasing these — have been attained only through large expenditures of capital. The economies incident to scientific management are attained, in the main, without additional capital investment. The introduction of scientific management would involve new expenses, mainly in the employment of new classes of labor; and their employment would be attended by the elimination of others. Indeed, the economies incident to scientific management, instead of calling for new capital, dispense to a large extent with the necessity of new capital. Many of the economies result from a fuller use of plant and equipment, and in the carrying of smaller stocks of materials. One of the commonest incidents of scientific management is the discovery that a plant believed to have been inadequate for the business undertaken proves to be too large or over-equipped.

(*a*) GANTT (Record, pp. 3475–3476).

"Mr. GANTT. Is it or not one of the incidents that you find in the introduction of your work that manufacturers have over-equipped?

Mr. GANTT. In many cases the manufacturers have over-equipped their plants without knowing what capacity they can get out of the individual machines. They have never studied the capacity of individual machines, completely and fully.

Mr. BRANDEIS. And it is one of the important incidents, I understand, of your system that the machine is rated and the capacity of the machine is considered, and the cost of it, as constantly as the cost of labor, of the individual man?

Mr. GANTT. We take the individual machine and find out what its limitations are, what its capacity is. We frequently find a machine which has been built by a very good builder that has some weak point in it. By fixing that weak point, putting in a steel gear where we have a cast iron gear, for instance, we can double the output of that machine or in many instances increase it 50 per cent. We go on under the full development of this system to keep on finding out what the limitations of that machine are until we make perhaps a half dozen changes in it and get it up to its highest capacity. The most expert man in that work is Mr. Barth. He has devoted himself especially to that. He has made great improvement in many machine tools."

(*b*) GANTT (Record, pp. 3474½–3475).

"Mr. GANTT. Yes, sir. With regard to that, I would like to say this: We have spent a tremendous amount of money in developing machinery and we have spent very little money in developing men. If we should spend one-tenth the amount of money we have spent in developing machinery to develop men, I firmly believe we would double the average efficiency of the whole country. That is belief. Of course I cannot prove that. But I am firmly of the conviction that if we should spend one-tenth the amount of money and energy we have spent in developing machinery in developing men, we would raise the whole standard tremendously.

Mr. BRANDEIS. Is it a fact that in none of the business with which you have been connected, have you found, however great the expenditure upon instruction, that in every case however great it was it proved to be profitable?

Mr. GANTT. I have found it is the most profitable investment that any manufacturer can make, to instruct and develop his workmen. I might go further and say that a great many manufacturers are beginning to realize that and they are doing quite a little in that regard."

28. *Saving* $1,000,000 *a Day*

The estimate that at least $1,000,000 a day could be saved by the pursuit of methods of scientific management was first made by Mr. Harrington Emerson.

It is submitted that, with aggregate operating expenses by the railroads in 1908 of $1,669,938,717, of which $1,035,437,528 was for labor, this estimate appears moderate.

Mr. Emerson states how he arrived at his conclusion.

(*a*) EMERSON (Record, pp. 3543–3551).

"Mr. BRANDEIS. You have been quoted, Mr. Emerson, as stating that in your opinion, by the introduction of proper efficiency system or scientific management, the railroads of the United States could effect an economy of perhaps $300,000,000 a year, or not less than $1,000,000 a day.

Mr. EMERSON. That is correct — that is, I have been quoted as having stated that.

Mr. BRANDEIS. Is it your opinion that that is the fact?

Mr. EMERSON. At least that.

Mr. BRANDEIS. And in which of the departments of the railroad operation is it that large economies can be effected, in your opinion?

Mr. EMERSON. In all the departments except traffic. The efficiency of the traffic by my standards is very high; that is, the efficiency of expense in the traffic departments.

Commissioner PROUTY. Just what do you mean by the traffic departments?

Mr. EMERSON. That is one of the classifications, one of the five classifications, is it not?

Commissioner PROUTY. You mean the traffic department as classified by the Interstate Commerce Commission?

Mr. EMERSON. Yes.

Mr. BRANDEIS. Would you state to the Commission on what you have based your estimate that so large an economy in operation is possible?

Mr. EMERSON. There were four different ways of attacking the

problem. The final conclusion is a composite from the results obtained by the four different methods.

First, the long experience I have had in investigating intimately American shops all over the country had led me to realize that certain inefficiencies existed in different classes of labor, inefficiencies due to the absence of proper standard methods. These inefficiencies averaged fairly well over the whole country. They averaged fairly well in all businesses. Taking those inefficiencies as my judgment determined them and applying them to the bills for labor and for material in the railroads, I arrived at a certain result, which aggregated in excess of $300,000,000. That was one way of getting at it.

Another way of getting at it was to take —

Commissioner PROUTY (*interposing*). Let us see if we understand that. Did you take the amount of the payroll in those departments and say that there was ten per cent actual inefficiency in this labor and subtract ten per cent from the amount of the payroll?

Mr. EMERSON. No, I took the report, for instance of 1908 —

Commissioner PROUTY (*interposing*). I do not mean that ten per cent was the figure you used, of course.

Mr. EMERSON. I understand. The total labor bill for 1908 was $1,035,000,000. That covered all of what I classify as personal services as distinguished from materials and capital charges. Those are the three elements of expense. These are classified as to different lines of operation. I put an efficiency opposite each one of these classes, based on my general knowledge, that would have applied to other business as well as to the railroad business, and, as you state, multiplied it and arrived in that way at an estimate of the inefficiency of labor.

Commissioner PROUTY. And that was over $300,000,000?

Mr. EMERSON. Oh, no, not for the labor alone.

Commissioner PROUTY. Do you remember how much it was for labor alone?

Mr. EMERSON. In the neighborhood of $240,000,000, I think it was, for labor alone.

The next plan was to take the divisions as provided for by the Interstate Commerce Commission, and using such knowledge as I had in my experience, to check up the different operations like locomotive repairs, car repairs, shop machinery and tools, and track work, and to take each item of the total bill for all the railroads —

$1,667,000,000, I think, for that year — and place opposite those items the inefficiency subdivided as to material and labor, and arrive at another estimate.

Commissioner PROUTY. What do you mean by "inefficiency of material"?

Mr. EMERSON. Engineers know very well and have determined how much horse-power you ought to get, or how much water you ought to evaporate from a pound of coal. If you are using a great deal more coal than that, there is an inefficiency. There is an ideal result which you ought to get which would be a horsepower from one-fifth of a pound of coal. The highest attainment they ever get is a horsepower from a pound. That is a very high ideal. If you find people are using either eight or nine or ten pounds of coal per horsepower, it measures a certain amount of inefficiency compared to the practically attainable. That is an illustration. The fuel is the largest single item of expense, so a large amount of this saving might be from the fuel. That is the second way of determining this waste. The third was the comparative methods. All railroads are efficient in certain directions. They are tremendously efficient in certain directions. Each railroad has some particular spot in which it is more fortunate perhaps than other railroads. Taking the different railroads of the country and visiting them and investigating them, and finding out that one had an efficient way as to maintenance of locomotives, another as to maintenance of cars, that a third had an efficient way as to maintenance of shop machinery and tools, and the fourth had an efficiency as to maintenance of track; and taking all these different bright spots that the railroads had evolved through the special genius of the men connected with or interested in those particular departments, you got a third standard — a standard, for instance, let us say, of six cents a mile as being an adequate amount on the average to maintain locomotives, or a standard of $35 as being an adequate standard to maintain cars.

Mr. BRANDEIS. Freight cars?

Mr. EMERSON. Freight cars. Some months ago, when I was addressing the Railway Club in Pittsburg, I stated this standard of $35 per car. Mr. Turner of the P. & L. E. was the spokesman of the opposition. He said they had been long waiting to get a chance at me, and the chance had now come; that they were tired of assertions of this kind being made, that they were from Missouri and the

time had come for a show down. He said: "Mr. Emerson states $37 a car. I want to know where he gets his facts and what right he has to get up any standard of that kind." I told them about a number of roads that had attained that, and the next day I went around to see Mr. Turner. I said, "Turner, what does it cost you to maintain your freight cars?"

He said, "I do not know. I never figured it out that way. I have always figured it by the mile and not by the freight car." I said, "Can you find out very easily what it is?" He said, "Yes." So in the course of half an hour his chief clerk brought in the figures, showing their cost of maintenance per car was $31.01. (Laughter). I very much regretted that I had not known that fact at the time they had me on the stand before the Club.

In the same way as to maintenance of locomotives. I think the records of the Pittsburg and Lake Erie are probably among the model records of the United States. In checking them up I found Mr. Turner had accomplished the maintenance of his locomotives, that are heavy power, for somewhere between $1200 and $1500, one of the lowest records I know of in the United States.

That is the third way of ascertaining standards. That means you can apply haphazard that standard to any road. It means it gives you a general average on which you can base a conclusion. That method checked up with the other two methods in revealing losses aggregating not less than $300,000,000.

The fourth method was in particular. In connection with the work of the Sante Fé we made an investigation or scientific investigation, of which you have heard from the other gentlemen on the same system. I took the costs as they were. I finally found out why those costs were, what losses were occurring, and what could be done by the management to eliminate those losses. We set up as a standard of measurement, because you have to have some unit or measurement, what has since been called the road unit. The road unit is a combination of the locomotive mileage with its weight on driver. If you take the locomotive alone, it may stand in the roundhouse for a whole year and would have no repairs. If you take the mileage alone, it might be a light locomotive running a number of miles, and that would not be a fair measurement; but when you combine the mileage the locomotive makes in the course of a year with its weight, you have a unit that at least in some respects is better than the unit of either the single locomotive or the locomotive miles.

Using that unit, we found in the fiscal year ending 1904 the cost of locomotives had been $101 per road unit as an average on the whole system. By investigating the matter and inducing the management to put in various scientific studies, that was reduced in the next year to $78, and in the third year to $74. At that time I presented to Mr. Kendrick an exhaustive study of locomotive operation, covering eighteen hundred locomotives and all their records for five years, as to all the different divisions and the different causes and the different items of expense. It was probably one of the most complete statements of locomotive operation that was ever made. I did not make it myself. It was made for me by one of my assistants, and with the assistance particularly of the statistical department. He could not have done anything if he had not had access to the vast accumulation of statistics that had been collected for use by that department.

Mr. BRANDEIS. You mean the statistical department of the Santa Fé?

Mr. EMERSON. Yes, the statistical department of the Santa Fé. I stated at that time, in final report, that I saw no reason why the Santa Fé should not be able to maintain its locomotives for fifty dollars per road unit. That was thirty-three per cent lower than they had attained at that time. I am still of that opinion.

That was the fourth method. The same system was applied to other items of locomotive work. Taking up those four methods, they all of them gave me substantially the same result, within $30,000,000 or $40,000,000 of each other."

(c) EMERSON (Record, pp. 3563–3564).

"Mr. BRANDEIS. Then your estimate as to the absence of efficiency and of the possible saving is based upon the assumption and belief and deduction that in the very large part of the service this high efficiency attained in the Chicago-New York trains is absent?

Mr. EMERSON. That is correct. I have studied the comparative records of the leading railroads of the United States and tested them by the unit standard cost. I have been in the shops of a great number of different railroads, my assistants have been in the shops of nearly all of the important railroads of the United States, either visiting them or working in them, so I have a very fair knowledge as to the extent in the past. At the present moment I do not know, but

up to the last year I know what the condition was in the various railroad shops of the country.

If I find that the unit cost of performance is high on a railroad, I conclude that one of two things is true: either that they do not have the methods of scientific management, or that there is an undue number of dependent sequences. It is due absolutely to one of those two things."

24. *The Commission should Undertake an Independent Investigation into the Application of Scientific Management to Railroads.*

We respectfully submit that in no event ought the Commission to approve the proposed increase in class rates without making an independent investigation into the possibilities of applying scientific management to railroads. We believe that the evidence already adduced will convince the Commission that such application is possible, and that it would result in the huge economy indicated. But, even if the evidence does not carry to the Commission that full conviction, it certainly is sufficient to create a reasonable ground to believe — particularly in the absence of any evidence from the railroads to the contrary — that the introduction of scientific management in railroads is possible, and that its introduction would be attended by great savings. If there is reasonable ground to believe this, the railroads have failed to sustain their burden of proof, that they need increased rates.

TOWNE (Record, pp. 3303–3305).

"In answer to the latter part of your question I would say this: That I am not here as an opponent of the railroads. I am not here to oppose the proposed increase of freight rates. I do not know whether the railroads should have it or not. If they are entitled to it, they ought to have it. But I see this fact, as a manufacturer; that

whereas, in other industries, when we are confronted by too close an approximation of our income to our expenditure, competitive conditions rarely if ever permit us to open the interval to the point which will cover a fair profit by putting our prices up. Our competitors will not permit of our doing that. We have to meet the competition, and therefore we are compelled to look within for the remedy, — not to pass the burden on to others, but to face it ourselves, and find some way of relief. We have done it — I am not speaking of my own case only, but of manufacturers generally — we have done it again and again, successfully, on a great scale in hundreds of thousands of cases; and it is one of the many illustrations of what is commonly understood as a blessing in disguise.

Under the stress of necessity, we have learned how to do things better and more efficiently, more economically than ever before, and thereby have made our plants and our capital more productive than they otherwise would have been.

Speaking from that experience, and from my general knowledge of such matters, not as an expert railroad man, I venture the opinion, and with confidence, that if the railroads will apply these modern methods of intensified management, scientifically planned and efficiently carried out, they will thereby affect economies that will aggregate many times in money value to them the benefit they would obtain from the proposed increase in the freight rates."

But aside from this failure of the railroads to maintain their burden of proof, we submit that the Commission ought, before allowing any increase of class rates, to fully investigate the subject of scientific management on its own behalf. Such a course is in any event desirable because much valuable evidence would be available to the Commission which is not available to us. This is particularly true because there are witnesses directly or indirectly connected with railroads particularly competent to testify on the subject, whose appearance at our instance would have been treated as an act of hostility to the railroads with whom they are affiliated or on whom, in large measure, they are dependent. An investigation undertaken by the Commission would secure this testimony and would also afford

the opportunity of full inquiry into the existing practices in railroad operation, and among other things, into certain experience in scientific management made by one of the railroads which has not presented any evidence on this subject, and as to which we were not in a position to make any disclosure to the Commission without breach of confidence.